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THE BEGINNINGS.

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THE AUTHOR OF

"NEW PAGES OF NATURAL HISTORY," 1869;
"THE CIRCLE OF LIGHT, OR DHAWALEGERI," 1869;
"THE INTERIOR OF THE EARTH," 1870;
"INCIDENTS IN THE BIOGRAPHY OF DUST," 1877.

"O Light inaccessible, in respect of which my Light is utter darkness; so reflect upon my weakness, that all the world may behold Thy strength."

QUARLES.

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LONDON:
TRÜBNER & CO., LUDGATE HILL.
1878.

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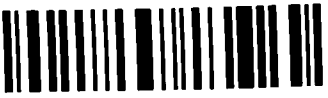
Ballantyne Press
BALLANTYNE AND HANSON, EDINBURGH
CHANDOS STREET, LONDON



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PREFACE.

THE little book before us contains observations on the Beginnings of this Earth. It talks of times anterior to those alluded to in "Incidents in the Biography of Dust," published in 1877 by Messrs. Trübner and Co. As these incidents were the natural and unavoidable results of the systems now to be discussed, it seems desirable to remove, as far as possible, certain erroneous impressions that have been conveyed to their respective circles of readers by a few reviewers. I endeavoured to induce these gentlemen to correct their errors; but they have fulfilled the prophecy contained in my Preface of last year, and are sad examples of the accuracy of Goethe—

"What you don't coin you're sure it will not pass."

The subject is very popular; it crops up perpetually in all kinds of literature. Professor Dawson has lately made a Beginning with days and nights of uncertain periods, failing to perceive that we have no evidence of change, and that the great laws which

give these characters must have commenced on very certain and decided principles. Late discoveries by Professor Crookes, as exemplified by his radiometer, might have convinced him of this; and the uniformity of motion, as laid down by Newton, should have shown the Professor that there never could have been irregular days and nights, and that ever since this earth has rotated on its axis, and has revolved round the sun, the days and the seasons must have been as they now are, in spite of Professor Tait and others. *Scribner's Magazine* of April, 1878, contains an earnest article on "The Mosaic Creation," by C. B. Waring, in which strange phenomena are attributed to the early days of creation; p. 820: "After the first day its crust retained heat enough to continue to hold the waters in a state of vapour . . . . dense masses of clouds, hundreds of miles thick, formed an envelope covering the globe. . . . . The oceans had become filled, and the thick clouds had gone . . . . one could see the heavens. . . . . This must have been a period of inconceivable violence and uproar, when ten million Niagaras were pouring down on a yet almost glowing crust." Harmonies between the Bible and science are then talked of, but are not shown; and science is said to be unwittingly approaching "the heights on which the author of this narrative (the Bible) stood four thousand years ago." I do not know from

whence these conditions were drawn, but they are not scientific, if that term depends on knowledge.

I now take the liberty of pointing out to the reader certain errors in those who volunteer to keep the public well and truly informed on such subjects as are placed before them for review. It is not to be expected that these reviewers should be qualified on all the points that come before them, so that false opinions may be pardoned; but errors in facts can only be assigned to incompetence, to haste, or to intentional misstatements. When the subject is of a controversial nature, and when opinions diverge widely, it is natural to expect a bias to crop up somewhere. This is scarcely fair to the public or to the authors. I do not imply that the former would gain much by reading the book referred to, "Incidents in the Biography of Dust," but it is, I hope, allowable to notice a few opinions and visible errors which certain reviewers have promulgated to their constituents.

The Academy, 7th April, 1877, wrote: "The author discourses on such recondite topics as the origin and history of the earth." The book carefully avoided origin. At p. 31 it says: "Dusts have nothing to do with the beginning. . . . . The root must remain incomprehensible." The reviewer then observed: "The author unquestionably lacks preparation in natural science . . . . which is ever ready to give up

its old teachings as soon as they have been shown to be out of harmony with advanced research." The only natural science the book touched on was in comparing many authors who had written on this so-called "science." As it stands at present, it is an ever varying subject, depending on the qualifications of individuals. It is the ideal against which I argue; it is the law of Nature that I argue for. When "natural science" has obtained some knowledge of that law, many of its present teachings must be relinquished; that law is always in harmony, and never changes with "*advanced research.*"

The Dundee Advertiser of 24th May, 1877, honoured my book with a waspish, but useful notice. It is possible that many may see with similar eyes; perhaps a brief explanation may clear off the haze. In noticing my theory, that mountains had been left by the retiring of the waters, the reviewer said, dogmatically: "Nothing like a sufficient quantity of land has been raised, to take the place of the waters thus retired." This opinion is given out to his readers as if it were a fact. The reviewer seems to think, that material removed from one part of the ocean bed to another, must be visible; he had not studied the undulations of that bed, as revealed to us by the labours of the *Challenger;* he knew nothing of the thickness of deposits on the present ocean bottom; he had not heard

of the 60,000 feet deep sedimentary deposits, revealed to us by the Geological Survey in America; all stratified, and now resting on primeval rocks above the present sea level. He does not know how much water has retired; the quantity in a state of evaporation, in the surface rivers, or in subterranean use. No one knows how much water is occupied by the vegetable and animal kingdoms. It has lately been shown, that a rainfall of "three inches equals 10,890 cubic feet per acre."—*The Mail*, 22nd April, 1878.

Geikie tells us in his Physical Geography, that the yearly British rainfall gives "about 68 cubic miles of water." This fall is about 22 inches; there are places where 300 inches have been registered; and it is supposed that between 40 and 50 inches of rain fall annually on the surface of this globe. Till we know all these things, it is impossible for Dundee, or any one else, to say how much water has retired, or to what depths it has retired; but we know that the whole area of the present dry land was at one time under water. We know that there are portions of that area about five miles above the ocean level, and that there are places in the ocean five miles deep. This equilibrium of elemental matter is explained as we go on. It will be seen, that under the system now suggested, the atmosphere, the water, and solid matter, must have been all mixed together; that as they sepa-

rated slowly and gradually, the air and water were perpetually assuming their own positions, while leaving the solid molecules to their own law of gravitation.

No one can tell how far the waters retired with the natural consolidating of the material; we do not know if the consolidation is completed. We do know that subterranean waters undermine the deposited strata, causing landslips, subsidences, and earthquakes; so that there are two causes constantly at work, suggesting a certain retiring of the waters to lower levels. At the same time it can be allowed, that subsidence in one place may cause an elevation in another; but when we displace the nebular hypothesis, we fall back on the laws of Nature, which have, as I read them, left us our highlands by the retiring of the sea. If I have succeeded in suggesting new points for the consideration of those who, like Dundee, are perplexed on this subject, then the opinion of the reviewer has had its use.

There is another point on which this scientific reviewer finds fault. He says: "Many contradictions may be found in the book—difficult to detect—owing to the vague style." Now Dundee proves himself a well-qualified judge of the vague: "There are, however, possibly and most probably still more visible agents and tangible materials which he (the author) does not use, and which would altogether overthrow

his theories." This is throwing plentiful dust in the eyes of his readers. I have no contradictions, no ambiguity. I use the dust of this earth as a material—air and water as agents, under their controller, the sun. If Dundee can produce less ambiguous causes and effects, he would confer a lasting benefit on his fellow-creatures.

The Popular Science Review, October, 1877, kicked up a cloud of dust, which settled down by its own natural density as far as I was concerned; but a passage, referring to others, is of consequence to future writers on these subjects: "The author exaggerates the extent of this Plutonism; and, after the manner of his kind, quotes over-strong, and perhaps hasty, statements of opinion, on the part of individual geologists, as if they constituted the accepted body of *geological science. In this process he naturally sometimes gets the best of it.*" The quotations referred to came from dead and living authors of high repute; they have not been withdrawn from their original pages, and no living authors have corrected their opinions on my pages. If any important truth depends on such opinions, and if it is perverted or improperly applied by me, I shall be very glad to be set right by the authors; but I cannot admit a reviewer to reflect upon opinions, as hasty, which have passed current for many years, some of them possibly on his

own pages. It would be satisfactory to the public, and save others from my mistake, if the *Popular Science Review* would explain who do constitute the "*accepted body of geological science.*" In other words, will he be good enough to point out the asses with the lion's skin?

John Bull of 8th September, 1877, literally fulfilled the prophecy in my Preface of last year. He fell into a Lord Dundreary spasm, and then "*The rest of this very silly book is devoted to proving all other geologists wrong, and Mr. Malet alone right.*" A great many heads were huddled together, but I undertook to prove no one wrong; as every opinion differed upon points where Nature had but one path, they could not all be right; but John shut up the book before he read, at pp. 222–3, that the gentlemen alluded to were particularly invited to prove a main point which never has been proved, and that, when this is done, the consequences of that phenomenon would be reconsidered. Of course *John Bull* has as much right to ventilate his opinion as swine have to eat up the pearls cast before them, and we may contrast it with the *Builder's Weekly Reporter*, 30th March, 1877: "*Great truths are embodied in language worthy of them.*"

I must now beg my readers' patience for a moment, by a reference to an explosion which has just taken place in the *University Magazine* for May, 1878; it

puts one in mind of a fizz from damped gunpowder, generally called a devil. I must give it entire :—

"Much intelligently directed reading, and much connected thought, have been signally wasted by Mr. Malet in support of the thesis, 'everything that lived or grew was composed of air, water, and dust.' 'The dry land of the earth,' he says, 'is dust.' 'The earth consists of air, water, and dust.' An arbitrary division of the chemical elements into one well-known chemical compound, one equally well-known gaseous mixture, and everything else, reminds one of the famous division of the human race into men, women, and Herveys. It is neither scientific, practical, nor poetical, and it is matter of regret to see so much labour wasted on so idle an affectation of scientific investigation."

The intelligent reading, and the connected thought, discovered by this "very capable reviewer," were found and practised from the harmony of Nature, its laws and actions, during a study of half a century. It is quite possible that the reviewer was one of those alluded to above, as overthrown; for him my time was wasted, but I still maintain that, had it not been for air, water, and dust, neither he, his pen, paper, ink, or irritation could have existed. If he can prove to the contrary, the arbitrary division of chemical elements will be made by himself. I have made none,

as he would have discovered if he had not fizzed off at the first page. Of course, there can be nothing scientific, practical, or poetical in a work beyond the capacity of a reader; but it is easy to express regret at the labour supposed to be wasted on such interminable conundrums as are most certainly formed and established by our elements, with the assistance of the sunshine. If I have succeeded in explaining truly one of Nature's phenomena, my time was not wasted. I made no affectation of scientific investigation, there was no scientific fact to investigate. I brought together many theories, unfounded on fact, but dignified, by such sciolists as my reviewer, as scientific. I refer him to the Epilogue of Dust, and beg him to answer the question at p. 223—he cannot be scientific in cosmogony till he does so. The reviewer has courteously called me idle. My book, which he undertook to review, and for doing which he was probably paid, contains some 270 pages, very full of the works of Nature. He noticed three or four abstract lines on the first page, and went off—fizz. It is a matter of regret to me that I cannot reciprocate his simple courtesy.

In the book referred to, I begged the future critics not to trouble themselves with my light details, as the main points were of importance. I now beg to apologise to the future reader for referring to those

spray flakes, which suited the ability of several. At the same time I beg to offer my thanks to those reviewers who read "Incidents in the Biography of Dust," and gave unbiassed notices of it to their constituents. Thus we pass on to the coming events, with a hope that future critics will confine themselves to facts, and not imagine that I am opposing science, but comprehend that I am now, as before, opposing those, who, under the name of science, promulgate their own unfounded opinions, and presume to call that silly which does not coincide with their narrow abilities.

I was led into the subjects, discussed in the following pages, partly by what I have previously published, and partly by a well-digested paper on "The Age of this Earth," in the *Quarterly Review* for July, 1875. Several sciences were brought together, but they could not determine the point within tens and hundreds of millions of years, while some gave themselves margins of 50 per cent. It was obvious that if the data for these scientific calculations had been founded on fact, their products could not have been so very uncertain. This index pointed to false data. The *Geographical Magazine* was good enough to publish my first chapter in February, 1877, pointing out that science is not in a position at present to arrive at any satisfactory conclusion, not from any error in its figures, but

from uncertain data as to the origin of this earth.

Pursuing the subject further, with the assistance of such materials as were within my reach, I found reasons for the uncertain calculations in the instability of the "nebular hypothesis"—Laplace—upon which they were founded. This astronomer was the first to throw a doubt upon his own theory, by observing that what is not "the result of observation or calculation," must be distrusted.—("System of the World," Laplace, vol. ii. p. 365. Translation by J. Pond, 1809.) Perhaps no theory was started under better auspices. Philosophers, astronomers, geologists, and physical sciences, all wanted a starting-point. The precision of calculations, and the apparent completeness of the system were acceptable to all; it satisfied the wants of each, and gave plausible explanations for certain phenomena which had been previously incomprehensible. The greatest authorities of the day accepted the system, and it has withstood the doubts that have been frequently lavished on it. The result of my research on this subject is set forth in Chapter II.

While engaged upon it I fell in with Dr. E. Gryzanovski, a disciple of the German astronomer Gruithuisen. Considering that the present was a fitting time to discuss the whole subject of the

Beginning, he kindly gave me the groundwork of the slow aggregation theory of his countryman. The detail of this theory is in Chapter III., with a sketch of a Beginning derived from the German and French cosmogonies. This chapter appeared in the *Geographical Magazine,* March and April, 1878. This aggregation theory is an ideal, but is put together generally with such persistent harmony, that it looks in many aspects like truth. Later discoveries destroy his harmonies, and leave nothing behind but matter, in some shape or another, previous to the consolidation of this earth.

When we applied the discovery of Mr. Crookes, that *light is force,* to this matter, we found at once an undulating power, which must have acted on matter in the condition supposed to have existed. By looking at the surface dry land; at the ocean bed, as revealed to us by the labours of the *Challenger;* at the sedimentary deposits and denudations exhibited to us by the Geological Survey of America by J. W. Powell, Uinta Mountains; by considering the results as shown by the spectroscope; and finally, by throwing in the liquefaction of the gases, as shown by M. Cailletet and M. Raoul Pictet, we seem to escape from the impulsive system of Laplace, to adopt the more natural slow aggregation of molecular matter of Gruithuisen, from the supposed nebulous mass floating

in space, as the only system under which the gases and the liquids could be liberated from their chaotic condition, and the only system under which those gases do now assume, and must, from their first acquaintance with sunlight, have assumed their present conditions of air and water. Thus, as I wrote nearly ten years ago, in the *Circle of Light:*

"Higher and higher arose the canopy of matter . . .
The division of the waters was then completed . . .
Step by step this world was working on!"

I wrote that from a long and close observation of the works of Nature, under cosmical laws. Science has been slowly but surely working up the same points, and facts before us seem to be the results of these laws, initiated by the first impact of the light on a nebulous mass, holding in its constituents the bases of our air, water, and the dusts of earth.

The chapter on the Separation of the Elements resulted from these facts. With all matter in perpetual motion, the pure mechanical actions become very complicated, horizons run into one another, and distant objects became indistinguishable. I have endeavoured to follow the natural sequence of events; with what success I cannot well determine; but it seems as if present knowledge utterly destroys the cosmogonies of the past, and requires a fresh and complete generalisation. I have endeavoured to do

this in the Epilogue; and so I launch the pages on the world with a word as to the present position of the Beginning.

The origin of light or of matter is not known.

Man accepts a nebulous condition of matter.

Upon this matter falls the light of the sun.

The results of to-day are similar to those of the Beginning.

I attempt to explain them as I go on.

H. P. MALET.

1878.

THE BEGINNINGS.

CHAPTER I.

THE AGE OF THIS EARTH.

We gave the manner of the birth of Dust last year, we have now something to say of his present age. This point has excited much attention, curiosity has stirred up ingenuity and invention. Philosophers have done their best to discover the marks, but they are all worn out; the age of this earth is not known, the nature of its origin is still undiscovered.

An able article in the *Quarterly Review* for July, 1875, gives the calculations of several sciences, differing from one another by tens and hundreds of millions of years, on the age of our cosmical system.

Physical Geography was not represented; we claim for it, not only as great a knowledge of facts in reference to the main point as any other science possesses, but the means of enabling us to point out, where sciences seem to be in error as to time, to data, and consequently in their complex calculations.

Mathematicians are so correct in their figures, that when they start from one point to reach one end, their ends ought to be the same; when these ends vary, and we find no fault in the calculation, we must look into the data for the cause of variation and error.

The article alluded to gives us an outline of cosmical beginnings from the theory of Laplace, published in "1796" (Maunder). Astronomers have been aware that many nebulæ floated in space; these became "specimens of worlds in making," under the powerful telescope of the French astronomer. As the nebulæ became denser, they came under "the action of gravity," consequently "a succession of rings, concentric with and revolving round the centre of gravity," were formed. "Each ring would break up into masses, which would be endued with motions of rotation, and would in consequence assume a spheroidal form. These masses formed the planets, and gathering with energy round its centre formed the sun." It is then explained, "that the earth could not have had an independent existence till long after that time . . . . for before then the earth must have formed part of the fiery mass of the sun." The *Quarterly* observing: "Thus probably was the world we live in, and the solar system of which we form a part, evolved out of chaos."

Science has proved that motion causes heat, and therefore the sun was provided with a supply by the action of the nebulæ. If they were cold when they came together, the only condition they could have been in, the supply of heat was calculated to last for 20,250,000 years at the present rate of consumption. Thus "the dynamical theory of the sun's heat renders it almost impossible that the earth's surface has been illuminated by the sun's rays many times ten millions of years; and when we consider underground temperature, we find ourselves driven to the conclusion that the existing state of things on earth, life on the earth, and all geological history showing continuity of life, must be limited within some such period of time as 100,000,000 years." This authority, Sir William Thomson, is reported to have told the British Association at Glasgow, that "50,000,000 years is an over estimate" for the age of this earth (*The Mail*, 8th of September, 1876).

A comfortable margin of 50 per cent. seems convenient to the precise sciences. Professor Tait is reported to have said in a late lecture at Glasgow, in alluding to differences on this subject, "so much the worse for geology as at present understood by its chief authorities, for physical considerations render it impossible that more than 10,000,000 or 15,000,000 of years can be granted." Before entering on physical

details it will be as well to point out a curious position between mathematicians and geologists in reference to "underground temperature." Some geologists assign all igneous action on this earth to local chemical causes; but the fashionable school allows its ignorance on this subject in the "Text-book of Geology," by Mr. Page, seventh edition, p. 51: "The occurrence of volcanoes, earthquakes, escapes of heated vapours, and thermal springs, are by far too numerous and general to be accounted for on any principle of chemical union with which we are acquainted." In other words, the expenditure of heat from the earth is supposed to be more than local chemical causes could supply. Mathematicians give "20,250,000" years of heat to the sun; as this earth is supposed to have been an offshoot from its "fiery mass," we may infer, that when the earth was detached, it must have been in the same hot condition as the parent mass. Mr. Proctor gives us the diameter of the sun at 850,000 miles, and Guyot's geography gives the diameter of this earth at 8000 miles. If, then, the diameter of the sun contained heat for 20,250,000 years, the diameter of this earth only held heat for 190,588 years. We know nothing of fresh supplies of fuel to earth or sun, in reference to the theory of Laplace; we give the sun the credit for greater expenditure of heat than the earth; but if geologists are right in supposing

that local chemical causes have been unequal to earth's expenditure, and that this has been going on for 10, 12, 50, or 100 millions of years, according to the calculations of physical science, we may wonder why the internal fire did not become bankrupt long ago. We may also remark, in passing, that if igneous action is of any advantage to this earth, it is lucky that neither science had any hand in its origin.

It was pointed out by the German metaphysician Kant, and has been accepted by others, that there has been a retardation of the earth's revolution from the tidal wave. The conclusion, as given in the *Quarterly*, is "she was rotating at about the same rapidity as now, when she became solid, and as the rate of rotation is certainly diminishing, the epoch of consolidation cannot be more than ten or twelve millions of years." This calculation cannot be of much consequence to the cosmical system; but as no one knows how the tidal wave acted, before there was land for it to flow and ebb upon, we put the theory down as useless, and accept the tidal action as a part of the dynamical action, that helps to keep the whole sphere in equilibrium.

We now come to a mixture of mathematics and geology. The late Sir Charles Lyell, calculating from the present growth of the dry land, put the age of this earth at 300,000,000 of years, the fossiliferous

strata at 240,000,000, and the glacial epoch at 1,000,000 years ago.

The earnest and accurate mathematician Croll endeavours to modify the geological epochs by a calculation "at once beautiful, simple, and complete. . . . . The land has been many times under the sea, and the most violent changes of climate have succeeded one another." Causes are produced to show "that every 10,000 years or thereabouts the winter of the northern hemisphere will occur, ... whenever any records are left of the glacial epoch, a general subsidence of the land followed closely on the appearance of the ice, ... the extent of submergence will be in proportion to the weight of ice, ... glaciation would be transferred from one hemisphere to another every 10,000 years. There would be elevation of the land during the warm period, and subsidence during the cold."

The article goes on to tell us, that "the discovery of Mr. Croll upsets the whole scale of geological time." Croll gives four periods of glaciation, the last of which was 200,000 years ago; so that the glacial period is reduced to that age—the date of the fossiliferous rocks to 48,000,000, and the age of the earth to 60,000,000 of years.

All glacial epochs are supposed to have left their marks behind them. Croll says they occur every

10,000 years; but the writer of the article has left out twenty of these periods, and selected one of Mr. Croll's without knowing whether Sir Charles Lyell referred to that particular period or to another, which Croll tells us took place 850,000 years ago. As figures go in this matter, Sir Charles would have a very small margin of 150,000 years, if he worked on the traces of this period. The writer of the article seems to have had an object in his figures, by reducing them as nearly as possible to his own.

We must now consider two more facts brought forward by Croll in support of his calculations.

First: "The land has been many times under the sea." . . . . "The submergence will be in proportion to the weight of ice." The latter quotation cannot be proved, ice vanishes, and its weight cannot be known. Submergence of land takes place all round the world. The causes are soft foundations and growing superstructures, pressures, sinkings below water, sedimental gatherings, gradual risings, and the repetition of the same actions till a solid foundation is secured. When foundations are undermined by subterranean water-action, submergences of surface areas may occur suddenly, and the rising again is uncertain.

Second: "Violent changes of climate have succeeded one another." Opinions vary as to the cause of this in the Arctic regions. Some follow Mr. Croll

in his see-saw system, or the oscillation of the Poles; under it changes of climate must ensue; but a very material point seems to have been forgotten—if the oscillation is cosmical, the water would go down with the land; there would be no submergence. There would be 10,000 years of ice, and 10,000 years of warmer climate. These changes would be general, but the fossils of warmer regions do not prove a general growth, neither do the warm region drifts of the present prove a general action through the Arctic regions. In the late Arctic expedition it was colder on one shore of Smith Sound than on the other, and Captain Sir George Nares gave his experience of the Arctic and Atlantic Oceans to the Royal Geographical Society.

In the Atlantic Ocean there is "an enormous reservoir of heat." This warm water is forced "gradually towards the northward and eastward, modifying the climate of all parts lying in its course. There is also a warm current ever running to the northward through Behring's Straits." These warm supplies run at present through certain channels, while in other channels "an icy cold current" runs to the southward. The Polar basin has a "warm stream of water constantly pouring into it between Spitzbergen and Norway, and a cold icy one as constantly running out between Spitzbergen and Greenland, also . . .

between Greenland and America; . . . . so great is the difference of climate caused by these powerful distributors of heat and cold, that the temperature of the sea . . . . 2200 miles from the Equator is precisely the same as that nearly double the distance from the Equator."

As we have these cosmical actions, guided by fixed cosmical laws, perpetually circulating the heat and the cold—not always in the same channels, but distributing both according to the direction of either current—we find a certain cause for the "violent changes of climate" alluded to, instead of the more than uncertain oscillation, with the doubtful results of Mr. Croll. We cannot agree with the author of the article in the *Quarterly*, or allow that this glacial theory in any way interferes with geological time, as laid down by the late Sir Charles Lyell. Having thus disposed of certain details as to the age of this earth, we must now briefly consider the position of our geological science on this point.

Properly speaking, geology is a discourse of things on or in the earth, of things tangible and visible. In accepting the theory of Laplace, the foundation of their science is neither tangible nor visible. It suited geology to adopt it, because, in the prevailing ignorance of natural laws, it seemed to explain the causes of certain phenomena. Now that a more accurate

knowledge of cosmical law is creeping up, there is no excuse for adhering longer to a theory which is incapable of explaining the cause of igneous phenomena on or in the earth, while it is made ridiculous by the little figures of the mathematicians.

We cannot meet the dogmas of science on this subject, because we think with a finite mind on an infinite beginning; but we ask geologists and mathematicians to follow us through a brief tracing of the cosmical laws and their actions from that beginning, as far as that has been revealed to us till now.

There was a void chaos of waters without form, and dark; how long this earth remained in this condition we do not know. Light was given, motion, day and night ensued, revolution on its axis had commenced and continued to this sphere its hours of labour and of rest. Another result followed the presence of light —water was attracted by it, as it is to-day; the water-clouds were collected in the firmament, and were divided from the waters under the firmament; all this law is in force now, but no one can say how long a time elapsed before the action became perfect and complete.

As the light caused a movement on the whole body of waters, so the waters acted on their bed. No one can say where the general level of that early bed was. But as it deepened from the ever-acting erosion of

the waters, they were of necessity gathered unto one place, and the bed which they had rested on became dry land.

No science can tell when this happened; we do not know where the first water-level was, the level of the dry land, or its locality; no one knows when light first shone upon earth, or when it first divided the elements; we cannot say how long the atmosphere and the water were occupied in forsaking the silicious nucleus of our earth, but we know that water gives silicious matter now. We cannot tell when the water was separated from the atmosphere, or how long the atmosphere retained in itself the elemental constituents of water and of earth. The mathematician and geologist have nothing to do with the subject before this event took place: there is nothing visible or tangible, no data for a single figure. The moment dry land is created the physical geographer begins his labours. They are not difficult; he knows the uncertain forces that work under cosmical laws on for-ever-changing materials; by knowing the results at present, he can tell those of the past. Far be it from us to suggest infallible action; we can but give a faint outline of the whole, but we give nothing that cannot be verified by the law and its actions at the present moment.

The geographer looks through time upon the face of the first dry land; he sees the watersheds giving

out their little trickles, all running down the slopes, all wearing away something in their course, all depositing some atoms on their way, and all carrying on to their little estuaries or deltas a constant succession of minute atoms. He sees the deltas constantly extending by the addition of atoms, and constantly rising in consequence of the retiring of the waters. He sees constant additions to the dry land made by the water in one place, and constant abstractions in another; he knows that every atom taken from the water-bed makes that bed deeper, and every atom taken from dry land helps eventually to extend its shores.

Under these actions he comprehends that the dry land must have gone on growing, and that the undulating ocean-bed must have grown deeper where its currents ran, and shallower where they did not; he traces the gradual growth of these shallow places, not by any forcible elevation of the mass, but by the slow departure of the water, by the sediments left upon them, by the eventual growth of vegetation, by the creation of life, by the elemental forces for ever returning their dusts, in some regions or another, to the extending deltas, and the growing dry land.

He looks upon the mud and sand-banks of to-day, and sees the same forces at work under the same laws; he knows that these forces acted under the

same laws at the beginning, and he knows that they acted on the materials then available, as they act on the materials of to-day. He marks through legends, history, and his own experience, the denudations and the additions of the sea-shores; he finds that in thousands of years the general contour of the dry land has remained the same; he finds localities have been added to and taken away. In these subtractions he sees the fossil remains of prehistoric organic structure torn from their resting-places in the calcareous rocks, he handles the flint nodule formed from the silicious dusts of diatoms and foraminiferæ, and finds the same dusts in course of deposit in the deepest parts of the ocean, telling him not only that these organisms have continued their races for millions of years, but that they have, for all those ages, left their dusts to subside upon the ocean-bed, certain evidence that the site on which we find the stratified calcareous rocks, with their lines of flint nodules, was once the ocean-bed. He may look on the sand collections now on our surf-beaten shores, on the wind-drifts of the great deserts, and on the sand-dunes in many regions; he does not know when they began to grow, but he sees on mountain-sides horizontal sandstone rocks several hundred feet in thickness, many miles in length and breadth. He knows that they were formed and gathered by the same forces that now

occupy hundreds of years in adding a few inches to the shores, and he is lost in thinking of the vast amount of silicious matter broken up, triturated into sand, and deposited by the water on its bed, and that bed hundreds of feet above his head. He finds the hard silicious rock in stratified form on the tops of our highest mountains, in their interior, and in the deepest seas, where it still wears away, and contributes atoms for deposit in other places. He is lost in the time occupied by the deepening of the sea, by the vastness of the deposits formed by it, far above its present surface-level, and by the extent of deposit now in progress in its depths. The geographer knows that every river is always bringing something to its estuary, yet its growth of dry land is very slow; he measures it, but he cannot tell by that measurement when the estuary of the Nile was 4000 miles from its present site. He has traced by inscription on the rocks between five and six thousand years old, that the river-bed is now twenty-four feet lower than it was then, and river sediments meet marine deposits at a higher level. It is nowhere supposed that the entire valley has been upheaved, but while it has been slowly growing by the constant increment of surface matter, the depth of the river has kept uniform with the slow retiring of the sea. Man may trace the Mississippi from its present watery delta back to its

tributaries in the Rocky Mountains, but it does not tell him when these, now great waters, trickled as little rills from the first dry land of those regions into the neighbouring sea. He looks upon the water-worn chasms of the Himalayas and the Alps, on the vast gorges of great rivers, he cannot say when those rivers began to run, or how long it took them to wear away the hard obstruction to their course, any easier than Sir Charles Lyell could tell the age of the Niagara Gorge.

He may see the vast structure of the coral insect now growing over thousands of miles in the Red Sea, but he does not know when those structures were commenced. He sees the stupendous mass of the Dolomite Mountains, he knows that these were all lodged as sedimental matter, where they now stand, by the same water-forces which had previously built up the silicious Alps; that all the materials of which they are formed were brought atom by atom, just as atoms are lodged on our sea-coasts to-day, by the waters, which were then deeper than the mountains are high, from places on the sea-bed which were shallower, places that were washed away, and deepened by the very force that broke up the coral banks, carried them away, and lodged them where they are. He can form no idea where or when the insects lived that gathered all this calcareous matter from their

water, how long it occupied them in constructing their palaces, how long they existed, when they were pulled to pieces, how long they were triturated by current and by wave, or when the atoms were permitted to become deposits.

He may look on the calcareous matter of the Jura Mountains, and know that they are formed from bones and shells of fauna that once lived on land or in the water; he knows that these masses were lodged in water as deep as the mountains are high, in minute fragments, with an occasional entire shell or an unbroken bone, but he knows nothing of the land or water in or on which the fauna lived. He cannot count the time occupied in the formation of these mountains, or tell for how many ages the fauna lived that left their dusts to form them. Wherever the physical geographer turns, he is lost in the lapse of ages. The waters have left their old beds, the land has acquired new dimensions. All dry lands have their high places, from which their watersheds convey their atoms away; every atom helps to extend dry land, the watersheds are the roads for the work, and the great waters are the agents for the separation of matter, and for its deposit in its proper place. All this is done now under certain laws by their cosmical agents, air and water.

No one knows better than the physical geographer

the truth of the words used by the writer in the *Quarterly Review*: "In all the operations of Nature . . . . God worked by law . . . . by the process of slow development, by means beautifully simple, involving no violence, no haste, yet irresistible." No one sees more clearly the error, ascribed to Professor P. G. Tait, in *The Mail*, 8th January, 1877—"the present state of things has not been evolved through infinite past time by the agency of laws now at work, but must have had a distinct beginning." When was it, and what was it?

It is the slow, the certain, the beautiful, and the unchanging process of cosmical law, which gives the character of infinite to the universe. Finite man has not as yet read the pages of the law, and cannot therefore calculate the age of this earth. He has tried over and over again to do so, but Professor Tait is not so near to the truth as Solomon was; other "guesses" (*Quarterly*) may be nearer, but the men who guess are at present without chart, compass, or sounding line on the fathomless and boundless ocean of eternity.

CHAPTER II.

LAPLACE.

SOLOMON ridiculed the idea of man being able to discover the ends of the world. Man has, however, ventured on the task of finding the beginning of our solar system. The French astronomer Laplace takes the first place amongst the labourers; and his system, adopted by Arago, has been accepted by recent and present sciences.

The uncertainty, and the numerous contradictions in scientific literature suggest the idea, that the system laid down by Laplace has been imperfectly comprehended, or that the system itself is imperfect. In the "System of the World," by P. S. Laplace, translated by J. Pond, F.R.S., 1809, vol. ii. p. 365, we find:—"Whatever may have been the origin of this arrangement of the planetary system, which I offer with that distrust which everything ought so inspire, that is not the result of observation or calculation, it is certain that its elements are so arranged that it must possess the greatest stability, if foreign observations do not disturb it."

The observations anticipated by Laplace seem to have been made, and the time has come for the present scientific world to determine how far the nebular hypothesis can be trusted. One of the first to offer a new interpretation of the beginning was the German astronomer Gruithuisen, who entirely reversed the French theory. Nature has not two ways of doing one thing, but both astronomers have their disciples; and some English science trends towards the slow, cold aggregation of matter, in opposition to the impulsive consolidation of Laplace.

Present philosophers have lately placed before us many results of their thoughts as to the condition of this earth in connexion with this illustrious theory. Our object now is to consider some of these writings, premising that we only take that which is useful in eliciting the truth, while they contain materials for many volumes on world-making.

We shall confine the subject as closely and as briefly as possible to the earth as a whole. It is supposed to have a solid nucleus, composed of varied materials called metals and minerals, forming the body of this earth; upon this body rests a liquid called water; this water and earth are surrounded or enveloped in an invisible elastic fluid called air. These three materials occupy a space with a mean diameter of about eight thousand miles, of which

some fifty miles are air. Water is everywhere, in the air, and in the earth, but, as a separate distinct element, it occupies about two-thirds of the surface called sea, with an irregular depth, the extreme limit of which is about five miles. That part of the earth which is distinct and separate from the sea is called dry land; it has an irregular surface, and has a limit of about five miles above the level of the sea. The three elements, air, water, and earth, are in perfect harmony and unison, forming the sphere we live on, called earth. As one body, and as individual elements, this earth is under the control of law. The ostensible lawgiver is the sun, acting on separate individual elemental matter, giving an action of rotation on its own axis to the whole, causing it to revolve round itself, the sun, allowing an oscillation of the poles, but retaining the sphere in space at a certain distance from himself. This distance was given in the *Quarterly Review* for July, 1875, at "91,000,000 miles;" but the *Academy* of 20th October, 1877, on the authority of the Astronomer Royal, gives a corrected distance of "93,300,000 miles." When we come to these incomprehensible distances, the difference of a few million of miles, more or less, is of little consequence as a matter of fact, but of great consequence to the precise sciences. It is also important to understand that the present visible

surface of land and water is no proof of the conditiou of either in the beginning.

As we must refer to several publications, it is as well to mention them at once, noting their respective numbers when we use them :—

No. 1.—*Quarterly Review*, July, 1875. "Modern Philosophy on the Probable Age of the World."

No. 2.—*Popular Science Review*, January, 1875. "The Nebular Hypothesis ; its Present Condition." By John J. Plummer, M.A.

No. 3.—The same for January, 1877. "Condition of the Larger Planets." By Richard A. Proctor, F.R.G.S.

No. 4.—*The Quarterly Journal of Science*, April, 1877. "On Underground Temperature," &c. By O. Fisher, LL.D., M.A., F.G.S.

No. 5.—*The Mail*, 8th September, 1876. British Association. "Physical Science." Professor Sir William Thomson.

No. 6.—*The Mail*, 17th August, 1877. British Association. "Address." Professor Allan Thomson.

No. 7.—*The Mail*, 3rd October, 1877. "On Science." Professor Tyndall. And a few others.

The sun is the centre of the system to which this earth belongs. Eight planets occupy space at varied

distances from that centre; the most distant is called Neptune, at 2,743,000,000, with an orbit of about 5,500,000,000 miles in diameter, giving a circumference to the circle of more than 17,000,000,000 miles. In 1796 Laplace published his vast idea of world-making, filling this enormous space with nebulous matter. This matter, says No. 1, "*possessed a rotatory motion round its centre of gravity, and the parts of it which were situated at the limits where the centrifugal force exactly counterbalanced the attractive force of the central nucleus were abandoned by the central mass. Thus, as the nucleus became more and more dense under the action of gravity, were formed a succession of rings concentric with, and revolving round, the centre of gravity. Each ring would break up into masses, which would be endued with motions of rotation, and would in consequence assume a spheroidal form. These masses formed the various planets, which in their turn condensing, cast off in some instances their outlying rings, as the central mass had done, and thus formed the moons, or satellites, which accompany the planets. As each planet was in turn cast off, the central mass contracted itself within the orbit of the last formed; till after casting off Mercury it gathered with immense energy round its own centre, and formed the sun.*" This "*Nebular hypothesis of Laplace must be accepted as the explanation of the source of the*

sun's energy."—The Mail, 8th January, 1877, on Physical Lectures by Professor Tait.

Man was dazzled by the grandeur of the conception; and the *Quarterly,* above referred to, thought that as time went on, "*The saying of Arago will be accepted, and that the views of Laplace will be universally acknowledged to be those only . . . . which can be truly considered to form a physical cosmogony.*"

There are reasons for supposing that the system "*thus organised and isolated was brought into existence* No. 1. *by one continuous act of creative energy, and that however long the period over which the process may have been spread, the whole solar system forms part of one creation.*" Each body is in harmony with the whole; for a known period of two thousand years the length of the day on this earth "*has certainly not been di-* No. 1. *minished by one hundredth part of a second,*" a grand example of the cosmical law laid down by Newton: "Motion *unresisted remains uniform for ever.*"

Confining ourselves to this earth, we have a grand dogma, which may be put thus: "*Earth was consolidated from a nebula.*" Arago believed it, British science has accepted it, and still believes, with few exceptions, that "*the earth must have formed part of* No. 1. *the fiery mass of the sun.*" This fire is still supposed to be within it, and is held responsible for all igneous action on the surface, including volcanoes,

hot springs, and hot mud ejections. The molten interior is also supposed to be responsible for the undulations or coruscations on the earth's surface, which we call mountains. The mass is supposed to have cooled gradually on its exterior, in doing so it has contracted, and set up ridges like brown paper in the process of drying, or like bricks set on their edges.

Laplace brought his worlds together by force. It has been demonstrated that every form of motion is
No. 1. convertible into heat, and therefore "*if the particles of a vast vapour mass were brought into collision from the effect of their mutual attraction, intense heat would ensue.*" This is undeniable; but we do not know by what force the cosmical matter was brought together. There is no doubt as to the unity of Nature. Pro-
No. 7. fessor Tyndall told us, "*that there is nothing gratuitous in physical nature, no expenditure without equivalent gain, no gain without equivalent expenditure.*" Then he asks, "*Has this uniformity of Nature ever been broken? The reply is 'not to the knowledge of science;'*" as far as we know, then, inorganic matter is, and has continuously been, under one law. As far as we know, the forces of this earth are acted on by the ostensible lawgiver—the sun; the air, water, and matter are all subservient to his heat and light. We are not alluding here to local action. The atmosphere

is moved, the water is warmed and moved, both influence matter, and each element contains its parts of lightness and gravity: the denser the air, the greater its pressure; the denser the water, the deeper it sinks; and the denser the matter, the readier it accepts the material law of gravitation. There are limits to the elemental forces, but whatever force is used locally, the whole elemental action on elemental matter is slow and gradual; we know of no break in the system, and it seems to have been as it is now, back to the beginning. We have no known cosmical lawgiver but the sun, nothing is hid from the light thereof, and no element can avoid his influence. Under the nebular hypothesis motion and action are produced before the sun, and before any known cause existed to produce either one or the other. If any cause existed for the rotatory motion, we might accept the centrifugal action with the consequent rings cast off in turn from the vast mass, and we might imagine that, coming from the same nebula, each ring, and consequently each sphere, would be identical in composition. We shall find presently that the conditions of planets vary, and as there is no cause for the original motion, we must reject both motion and action as beyond the law. James Haig, a deep reasoner on things around us, but a believer in the nebular hypothesis, tells us in "Phi-

losophy on the Science of Truth :" " Do let us cease to talk of the mechanism of the heavens until we know more of their mechanism." We have not advanced much in this knowledge, for Professor Allan Thomson told the British Association at Plymouth, " that we are just as ignorant of the mode of first origin of all the compounds of inorganic elements as we are of that of living matter" (No. 6). But man goes on reasoning on the origin of the earth, not only as if he knew all about it, but actually accepts data for precise calculations, and deduces results from things unknown.

No. 2 tells us, " *Previously to the revelations of the spectroscope the nebular hypothesis stood at a very low ebb. The gradual increase in the power of telescopes . . . . had one by one reduced the number of so-called nebulæ by resolving them into clusters of distant stars, while others are simply mechanical mixtures of three gases—of equal or nearly equal density—in a state of very low tension, facts which are fatal to the hypothesis.*" Mr. Plummer thinks that no sufficient force has been suggested for the supposed original heat of this system-forming nebulæ. " *But a still more fatal objection would appear to be, that the gases which have been identified in the nebulæ do not seem to be, in themselves, adequate to form a system such as our own, unless by the addition of foreign matter from without.*"

Mr. Plummer has a view of his own, as to the supply of foreign matter, which he suggests may have been made by comets; but "*our imperfect knowledge*" of their constitution forbids our saying, that either foreign matter was supplied, or heat given to the nebulæ by comets; we do not even know whether comets existed in the beginning. The paper, however, concludes thus:—"*Both these questions require to be answered satisfactorily, before it is possible to declare whether the celebrated hypothesis of Laplace is or is not the true key to the solution of the formation and history of the solar system.*" We refer the curious to Mr. Plummer; we are content at present with a little of his evidence.

No. 3 gives the "Condition of the Larger Planets," by Richard A. Proctor. We are told, "*It is rendered to all intents and purposes certain, as well from the evidence of the earth's crust, as from that given by the movements of the sun, planets, asteroids, and satellites, that the solar system was developed from a former nebulous condition.*" We accept the result as a postulate; but the manner of development is the question. Mr. Proctor says it "*may have been that conceived by Laplace, in his nebular hypothesis, which may be called the contraction theory, or that recently suggested by meteoric discoveries, which may be called the accretion theory; or far more probably the solar*

system was formed by combined processes of contraction and accretion; in any case, the planets as severally formed were intensely heated. . . . . It is no longer supposed, as in Laplace's time was the case, that the outermost planets were formed first." We pause a moment here to remark, that if we disarrange any one part of the system, as laid down by Laplace, we throw the whole out of gear. Inner rings could not have been thrown off before the outer rings had gone. Mr. Proctor points out, that the ring system of Saturn is suggestive of matter *"not completely worked up."* If we allow that any incomplete action was a part of Laplace's system of world-making, how was it that the matter, when thrown off into rings from the central mass, ever left the ring formation on the concentric circle to which each ring belonged? There are rings flying round Saturn still; it is possible that the inhabitants of that planet may see rings revolving with this earth. The fact seems to be that, notwithstanding the completeness and perfection of our solar system, it is not as yet worked up in the comprehension of man.

No. 1 tells us, *"The sun must have had time to condense from its outer limits as a nebula to within the limits of the earth's orbit before that separate existence could begin; for before then the earth must have formed part of the fiery mass of the sun."* But No. 3 says,

"*Jupiter and Saturn have not yet passed through the first stage of planetary development.*" We do not know what is meant by the first stage. In the system of Laplace, the ring was the first process, and the globe or sphere was the second. Both of these planets are in the second stage, and only require cooling to be in the third stage of development according to Laplace.

There is, however, another point to consider before we can allow that this earth ever formed a part of the sun. Under the theory of Laplace, we have a reason for supposing that the constitutions of the respective planets would be similar. The spectroscope reveals a similarity without identity of composition. No. 3 tells us, "Jupiter's mean density is therefore about one-fourth, Saturn's almost one-seventh of the earth's." How is this, if all three were formed from one nebula by the same force, and with the same action? And then, why are they not so dense, and only so "very much hotter than the earth?" These differences do not imply a sameness of origin. Again, we have strange varieties of distance for matter thrown off from one central mass by one force. The distance between Mercury and Venus is 31, Venus and Earth 35, Earth and Mars 48, Mars and Jupiter 136, Jupiter and Saturn 396, Saturn and Uranus 1356, Uranus and Neptune 991 millions of miles. (See *Note* in No. 1,

p. 209.) If all were formed, as supposed, by "one act of creation" (No. 1), we must have a cause for the differences; and then, if other planets, which were cast off before the earth, are still masses of fire, it might be necessary to explain why this earth, composed of similar materials, belonging to the same centre, and cast off in exactly the same way, ever became cool enough to admit upon it vegetation or life?

Leaving these questions unanswered, we now come to indirect attacks on the great hypothesis. One of its main results was, that the ring, when cast off, retained the heat of the body from which it was cast off, and that on passing from the condition of a ring into that of a globe, the heat was retained in its body. As all heated masses cool from the outside, it was imagined that the interior was in a molten condition; that it has, by this innate heat, supplied the causes for all volcanic and other igneous action on the earth's surface, from the beginning of these actions till now, and causes a progressive increase of heat with depth. I find it is said in *Chambers' Journal,* that so long ago as 1847, "The doctrine of central fire has been for some time yielding to other views." We meet many ideas on the subject; but we must confine ourselves to this internal innate heat. *The Mail,* 8th September, 1876 (No. 5), reported, that Sir William Thomson

told the Physical Section of the British Association at Glasgow—"*The greatest depths to which we have reached in observations of underground temperature, is scarcely one kilometre:*" nearly five-eighths of a mile, or about 1100 yards; and, having allowed this limit of knowledge, he said, "*The evidence of a high internal temperature is too well known to need any quotation of particulars at present.*" The only evidence we have is founded on imagination. Some think that the heat in our mines has its source in the interior, that volcanoes are also due to the heat there; but there is no proof of it, and as it rests solely on the hypothesis of Laplace, and as that would make the inner depths the hottest, we will see how Sir William treats the interior: "*We may be quite sure the earth is solid in its interior . . . . and we must utterly reject any geological hypothesis that assumes the solid earth to be a shell, resting on an interior liquid mass.*" This is a very decided rejection of the main result of the nebular hypothesis; but Sir William hangs his faith on that, and is very much puzzled as to consequences; in fact, he becomes very nebulous, for his earth is not solid, "*absolutely throughout its whole volume, for there certainly are spaces in volcanic regions occupied by liquid lava.*" He gives no particular depth to these hollow places; but he lays the burden of a solid earth on "Hopkins." We are very much obliged to Sir William for assign-

ing local spaces for lava; but in rejecting the result of Laplace, we should have been glad if he had substituted another cause for lava. As his evidence stands, it acts indirectly against the nebular hypothesis, and in favour of none.

Bearing in mind the limit given to our knowledge of the interior earth, we take up the *Quarterly Journal of Science* for April, 1877 (No. 4), which gives us an article "On Underground Temperature," by the Rev. O. Fisher. He begins—"*There is no fact more firmly established in terrestrial physics than that the temperature of the rocks of the earth's surface increases with increasing depth.*" He has no knowledge of the condition of the nucleus rock. The whole of our mines, bores, and wells are in deposits; in no two of them is the heat equal at the same depth, but as these deposits contain in their constitutions more or less of earth's produce, and as no two localities are subjected to the same amount of pressure, we cannot have equality of heat underground. It was this fluctuating condition that led "*practical men engaged in mining operations* (to the opinion) *that the temperature in deep mines is due to the pressure of overlying strata.*" Most people would imagine that the opinions of these men were worthy of some consideration; the more so, as Mr. Fisher allows "*that considerable heat sometimes accompanies this creep.*" Yet says he, "We may unhesi-

tatingly dismiss this hypothesis." Curiously enough, Mr. Fisher goes a long way to confirm it. He brings in the Rosebridge Colliery as a sample of irregular heat. The manager of this mine wrote to us some years ago, expressing his opinion that the heat in the mine was due to local causes. We are then taken on to Sperenberg, where the depth of 4172 feet has been reached, and where heat actually diminishes with depth; thus in the table at p. 178, "1100 *ft. give* 1° *F. for* 42 *feet;* 2100 *ft.* 1° *F. for* 57 *feet;* 2700 *ft. give* 1° *F. for* 95 *feet; and at* 4042 *feet of depth, there is the same heat of* 1° *F. for* 95 *feet.*" These observations were made with great care by Herr Dunker, Inspector of Mines, and were commented on by Professor Mohr, of Bohn. This gentleman came to the conclusion "*that the source of heat within the crust of the earth was situated within the crust itself, for that after a certain depth was reached—which he put at* 5170 *feet—the increase would be nil.*" This conclusion came under the notice of the Committee on Underground Temperature of the British Association, and it was discovered that "*the law which brought the increase of heat to nil at* 5170 *feet was of Dunker's making, and not of Dame Nature's.*" Mr. Fisher calls the conclusion "*remarkable;*" but Mohr was right as far as the Sperenberg Mine was concerned; only he had no occasion to generalise. The heat, in sedimen-

tary deposits, having its source *in situ*, must diminish towards the end of those deposits which have any heating matter in them. The depth of these deposits is uncertain; consequently, the measure of one mine gives no datum for calculations on another; but as all deposits contain in them organic matter, or no organic matter, it follows that the latter have comparatively no heat, while the former must have heat in proportion to the heat-bearing quantities of matter in the deposit. As Mr. Fisher can never find equality of heat in equal depths, he asks, "*What is the law regulating the increase of heat?*" When Mr. Fisher can prove that there is an internal fire down below the deposits of earth, it will be time to consider the laws by which this heat approaches the surface. Till then we may be content with the subterranean heat in sedimental deposits, and the laws which regulate it. At this point science is in the dark, though it is from these laws that all the grandeur and magnificence of Nature spring. Sunshine or its absence act on life, death, and burial—on evaporation, absorption, repulsion, electricity, and magnetism. Then we have uncounted indirect influences—density, porosity, preservation, oxidation, chemical changes, alliances, and compositions, for ever changing, for ever wonderful—unknown and untold, because the same law is for ever acting on varied materials with varied results.

Is it strange that in this ignorance of law we do not give the sedimentary deposits credit for their varying heat? and is it strange that materials, produced in sunshine, should give an average temperature of 1° F. for about every 50 feet of depth?

Mr. Fisher founds his theory on a heated interior, the great result of the nebular hypothesis, so "*it seems clear, that if the views of Sir W. Thomson upon this point are correct, then the inequalities of the earth's surface are not due to the contraction of the sphere; if, on the other hand, the inequalities are due to contraction, there is strong reason to doubt that the earth became solid throughout, and that it is now cooling as a solid.*" The uncertainty of subterranean heat is fairly illustrated by the IFS of Mr. Fisher. We may as well illustrate the position more forcibly. The late Professor John Phillips told us in "Vesuvius," that a temperature of 212° F. "would be found it is probable under London, at about 8100 feet." The *Geological Magazine*, vol. x. No. 12, p. 538, tells us that rock may melt at about "800° F.," so that a simple calculation gives about 30,570 feet as the depth of Mr. Fisher's liquid stratum; this would be very dangerous to all things liable to injury by heat on the surface of earth, or on the ocean-bed; luckily, it does not seem to be a fact: Durochen taught that the solid crust was some "twenty-five miles" thick, and Mr. Haugh-

ton thought that 2500 were equally entitled to consideration. The confusion on this subject ends in a local fact, "The Geology of the Uinta Mountains," by J. W. Powell, Washington Printing Office, 1876, in which degradations of 30,000 feet are alluded to at p. 33, and "a general section of sedimentary beds alone, make a total of 60,000 feet," p. 37. Surely this is some of Socrates' *science with a difference.* It is by no means surprising that we find several men differing in their opinions of unknown causes and effects, but it is strange when we find one man giving different figures for the same event. In No. 5 we read, "*If* 3000° *would melt the substance at a depth of* 60 *kilometres, we should be compelled to conclude that* 50,000,000 *of years is an over-estimate for the age of this earth.*" But in No. 1 we find, "*When we consider underground temperature, we find ourselves driven to the conclusion, that the existing state of things on earth . . . . and all geological history showing continuity of life, must be limited within some such period of past time as* 100,000,000 *of years.*" By this doctrine, we learn that life existed 50,000,000 years before the earth. But all depends on the temperature at which the rock would melt, and the depth of the melting. If precise science is obliged to leave a margin of 50 per cent., students must be left in chaos. Mr. Fisher, however, puts us into another puzzle; he

has already told us of the certain increase of heat with depth, and now he tells us that he does not think we can found upon the "*observed rate of in-* No. 4.
crease of temperature in the crust, any theory as to the age of the world, or of distribution of heat in the interior." We ask, in passing, what is the meaning of the word crust? Is it the surface matter composed of all the dusts of earth resting in deposits on the face of the nucleus, or is it some imaginary surface of the solid earth? We leave the question unanswered, merely remarking that in the common acceptation of crust, it applies to a substance extracted from the interior of certain compositions by external heat. So we have the bark of a tree, the skin of fruit, the hides and hair of animals, the feathers of birds, all derived from the internal matter, all due to attraction by light and heat from an external source: perhaps some people will allow that most of the deposits of matter, resting on the nucleus, belonged at one time of their existence to organisms, which were liable to the same law of attraction, and hence may deserve the name of crust better than any unknown substance supposed to be derived from an unknown internal fire. Leaving this chaos for time to level, we come upon a point which seems suggestive.

No. 1 tells us, "*The amount of heat given off by radiation in a year is known; the total amount of work*

performed by gravitation in condensing a nebulous mass to an orb of the sun's present size is known. The result is, that the amount of heat, thus produced by gravitation, would suffice for about twenty millions and a quarter of years" (20,250,000). This if the nebulous matter was cold, but if it was hot, *"nearly fifty millions of years must have been stored up in the mass as original temperature. This added to the* 20,250,000 *. . . . gives rather more than seventy millions of years' sun heat."* Without entering on the question as to whether the nebula was hot or cold before condensation commenced, we find that if the sun, with a diameter of 850,000 miles, contains so many years' heat from its initial condensation, then this earth, as "a part of the fiery mass of the sun," and with a diameter of 8000 miles, must have held heat enough to last at the sun's rate of radiation for 190,588 or 658,823 years, according as the original nebulous matter was hot or cold. Mr. Plummer did not think there was any proof of previous heat in the nebula, but it seems to us very important to know under which of those conditions this earth was formed, before we calculate on its present condition of heat. We do not know the amount of radiation of heat from the earth's surface, if there is any, neither can we estimate the quantity of heat that has issued from volcanoes since they began; we have no date for their

beginning, but Werner told us they did not happen at the beginning of this earth. Here we again drift into chaos; let us see if Mr. Fisher can help us. Having rejected at once the opinion of practical men as to local causes of heat, he returns to the great cause of these phenomena. "*Sir Humphry Davy ascribed the volcanic fires to the oxidation of earthy and metallic bases,*" and by the chemical action of water on these materials, "*a generally diffused increase of temperature was supposed to arise, and to manifest itself by its escape* towards the surface:" of course this "*supposed*" heat could not meet the views of Mr. Fisher, but if we accept the bird in the net of Sir Humphry, instead of the one in the bush of Mr. Fisher, we are at once relieved of the chaos of sun heat, and earth heat, of nebulæ hot or nebulæ cold, and find that Sir Humphry Davy, Werner, Mohr, Dunker, and the other "*practical men,*" must be correct in their theories of local causes of heat.

No. 4, however, still tries to keep us in the nebula, "a very fascinating theory, which has met with support among many scientific men, has of late years been promulgated by M. (Robert) Mallet, who considers the heat of volcanic action to be derived from the transformed work of crushing the rocks of the earth's crust, owing to the contraction of the interior through long-sustained cooling." Mr. Fisher did not

seem to know that this theory was suggested by Herr Gruithuisen, as published at Munich some thirty years ago, where it is still believed in by many; we shall revert to the subject when we take up Gruithuisen; all we can say here is, that as there is no proof of contraction, so there is no proof of heat by the crushing of rocks from that cause; Gruithuisen produced the crust without the contraction.

In the opposing theories and arguments of Mr. Fisher and Sir William Thomson, we have strong indirect evidence against the nebular hypothesis; this gave us a molten globe in the process of condensing. This act of condensation would secure the heat, and the consequent molten condition to the centre. Sir William says, the earth is solid except in volcanic localities, Mr. Fisher says we have a liquid stratum. We shall find, before we reach the end of the subject, that there is no occasion for a molten stratum, or hollow places in the solid nucleus of the earth beneath volcanic regions; but the system of Laplace creeps into teachings of all sorts; Professor Geikie, in his "Primer of Physical Geography," 1876, tells us at p. 110, "inside the earth is lodged a vast store of heat, by which the surface is shaken, rent open, upraised, or depressed." Physical geography can do without the vast store of unknown heat; it finds heat in those places where the currents of ocean have deposited the

igneous material, and where natural chemical causes act upon it, till hot springs, igneous action, or volcanic eruptions ensue, according to the strength of the fire cause, and the nature of the surrounding materals in the deposited crust, and not in the nucleus.

We are in a better position now than at the end of the eighteenth century as to nebulæ, gases, and the ocean-bed. The nebulæ now in space are systems of worlds indistinct in distance, or luminous gases unqualified for making worlds. The patient perseverance and the science of the officers and crew of the *Challenger*, have exposed a deep sea-bed, cold throughout, even to a depth of five miles nearer than our deepest mines, to the imaginary fires inherited from the nebulous system; but Professor Geikie tells geological pupils in his Primer of 1876, that metals would melt at 25 or 30 miles of subterranean depth. Is it not time to stop this teaching on a subject of which we are in utter ignorance, while those who teach dignify it with the name of science? Man is afraid to try the depths of the earth to the bottom of the crust deposits, for he finds the heat almost unbearable at half a mile; he meets exploding gases at less depths than that, while all round the ocean-bed, giving an area three times greater than the dry land, from half a mile to five miles of depth, he meets a cold bed. Is

there nothing to be learnt from this universal condition? Does it not give us evidence of no fire world? Do not the water and the crust of earth give us clear evidence of a sun as ruler and life giver? Do not the crust of earth and the surface of water tell us, that they preserve his energy and life? are not these hid in our subterranean and subaquean treasuries, till the heaped-up store overpowers its walls, and leaps up as water or as fire to regain the surface elements again, fulfilling the never-ending cycle of elemental change and life-like energy? We have referred to a few out of the many periodicals and addresses which touch upon the nebular hypothesis, we have taken the friends in preference to the enemies, for their direct or indirect testimony hold more weight than the dogmatic objections that we fall in with. While fully allowing the precision and mathematical skill with which the nebular hypothesis has been presented to us, there seems to be something so deficient in this beginning, that it is nowhere defined how the first impulsive motion took place; in the absence of this, the whole theory becomes like one of Raphael's pictures of the Holy Family, coherent in its colour, perfect in execution, grand in imagination, but not true. No. 1 believes in this theory, and has built many fanciful fabrics on it, as other painters have copied the imaginary angels of Raphael. No. 2 tells us,

"In the whole range of science there is no theory which has attracted so much attention, has passed through so many vicissitudes, and has been so earnestly and fondly supported in the face of opposing evidence, as the nebular hypothesis of Laplace .... that it may one day .... be recognised as an established truth, is the hope of many who are fascinated alike by its simplicity and its comprehensiveness. A hope that has often seemed to sustain it when the bulk of evidence has not appeared to be in its favour, and one in which the writer to some extent indulges, although well aware that it may require to undergo considerable modifications before it reaches that exalted position." This is plain and intelligible, and with it we finish controversial quotations, not because we have found their end, but because we have used enough to direct attention to the fact, that the nebular hypothesis of Laplace is without result or foundation, and that consequently all theories founded on this beginning must share in its destruction.

A very recent discovery aids us now in filling up an omission of Laplace. The existence of water is nowhere satisfactorily accounted for. *The Mail*, 9th January, 1878, tells us how Mr. Cailletet has produced water out of air under great pressure, and in a very cold temperature. He had also liquefied oxygen and nitrogen, and obtained a nebulous vapour from hydrogen, all under certain degrees of excessive cold and

pressure. *The Academy* of the 12th tells us that M. Raoul Pictet, of Geneva, has "succeeded in liquefying oxygen under similar conditions of cold and pressure." If we accept a primary nebulous condition of Mr. Proctor in the space now occupied by this earth and its atmosphere, we reach the exact conditions specified in these experiments. No heat having penetrated the darkness, the condition of temperature was naturally cold; as the molecules of matter gradually consolidated, they naturally produced a condition of pressure constantly increasing. By this pressure the gases were perpetually forced away from the consolidating molecules, as the lightest went first they became our atmosphere, as the denser portion of the gases came next they became our water. Thus what we have previously written is curiously confirmed, while the great subject is under consideration in many quarters. We need say nothing as to the cold; it is here now, as we have shown, in the bottom of the ocean, and it is in the atmosphere the higher we ascend. All the conditions are perfect for the slow gradual accumulating body of water now forming the great seas. We are still in want of the origin of the nebula.

We must now say a word of those whom we have drawn into this vortex of world-making. Each, named or unnamed, has our highest respect; he has laboured

honestly and earnestly with his individual ability on such data as were before him, and which he believed to be in the condition represented by him. It is not his fault if these data are not true, but it is his misfortune if the beautiful structures he has built on false data vanish with them. The greatest of consolations, however, remains; each has striven to add something to our knowledge of the system to which we all belong; each has supposed he was aiding to unravel the secret of the world; from whatever source it comes the discovery of it must be a prize to all lovers of truth; those who have comprehended this truth, and those who have not, will be equally grateful to the two men whose experiments have now placed a portion of the truth before them.

We have alluded to that deep reasoner James Haig before; we now quote from his "Symbolism:" "*No science can begin to exist till we assume fundamental categories, predicables, and axioms.*" If physical science, mathematicians, and professors of natural history had begun on their world-making with undeniable postulates, we should not have had the strange controversies as to the beginning of this earth, its age, its internal condition, its heated interior, and its surface actions as have lately been placed before us. As far as man knows, this earth with all things on it have worked from the beginning in an enforced

but harmonious obedience to an unrelaxing but never exacting law; one great cause acting on varied elements, separate or in unity, with for ever varying forces on for ever varied matter, in perpetually changing compositions, all tending to produce varied results ending in one stupendous magnificent whole—our atmosphere, our water, our earth.

There is only one axiom that we are able to form out of all that we have referred to; Laplace suggested it, and Mr. Proctor tells us "*It is rendered to all intents and purposes certain, that the solar system was developed from a former nebulous condition.*" We do not approach the origin of this condition, neither Solomon or any one else has found it, neither can we determine how this nebulous matter was consolidated till we have considered the theory of Gruithuisen; it is possible we may then approach the long-sought secret, so as to enable others to conclude the search. All we can come to now is far from the beginning; but when we reach a point, which has been for thousands of years beyond the comprehension of man, it seems natural to refer it to one almighty incomprehensible power, until the finite mind of man can grasp the infinite. As far then as we know at present, this earth, including its nucleus, its air, and its water, was developed from a nebulous condition.

CHAPTER III.

GRUITHUISEN.

THE British scientific world has no problem before it at the present moment of more importance than the beginning of this earth. How did it begin to be? Our natural sciences and their present controversies hang on this peg. We have been told by the President of the British Association, Professor Allan Thomson, "*that we are just as ignorant of the mode of first origin of all the compounds of the inorganic elements, as we are of that of living matter.*"

This was one of the most obvious truths in the learned and deeply-studied address to the scientific meeting at Plymouth. It has been often repeated since the time of Solomon; but in the face of this certain and acknowledged ignorance of primary details, men have invented—and men have accepted—certain theories of the beginning, not only of this earth, but of our solar system. On these ideals man is constantly engaged in explaining certain terrestrial phenomena, which cannot be explained truly without a knowledge of first principles. False interpretation

must follow ideal data; and so we have around us volumes of unfounded structures and theories, crumbling to their ruin in vast confusion. Powerful associations and liquid pens prop up these world-theories with buttress and with brass, but these are equally without foundation, and must share in the ruin of the principle they confide in. Something springs on the site of all ruins, it may be a thistle, a nettle, or a bramble; we only hope to plant one germ of truth.

Natural history, physical science, mathematics, astronomy, and geology have lately differed as to the age of this earth by hundreds of millions of years. They take their data from the nebular hypothesis of Laplace. If the data were true, precise science could not differ in results. The uncertainty of this theory is shown in the previous chapter; we take some of its main points for the sake of their contrast with the theory of the beginning by the German astronomer Gruithuisen. This theory was published at Munich, between 1832 and 1842, in *Neue Analecten* and *Astronomisches Jahrbüch.* The author must have had a full knowledge of the nebular theory, as it was published in 1796, and his ideal is exactly the reverse of that by the French astronomer.

During the last century Sir John Herschel discovered, and reported on, numbers of luminous nebulæ

floating in space. Laplace adopted the novelties as worlds in making. He imagined that a similar nebula once occupied the whole area now embraced by our solar system; he brought this mass under the laws of attraction and gravitation, extending over a a diameter of some 5,500,000,000 miles, forming the whole into one compact mass of rotating matter, which threw off by its centrifugal force, at varied distances, certain rings of matter, which formed our planets, till at last the planet Mercury was formed at a distance of 35,000,000 miles from the nucleus, which then "gathered with immense energy round its own centre, and formed the sun."* The ring which formed this earth having once belonged to "the fiery mass of the sun,"* retained its heat, and this is supposed to be still within the nucleus of this earth, providing the surface with its igneous phenomena.

Laplace made his solar system with so much mathematical precision, that astronomers, naturalists, physicists, and geologists, embraced the uncertain hypothesis as a sure solution of many puzzles, saving geologists much trouble in arranging causes and effects. Improvements in telescopes showed that some of the nebulæ of Laplace were distant systems of worlds, and it is known that other nebulæ, now

* *Quarterly Review*, July, 1875.

floating in space, are luminous vapours, having in them certain gases inadequate to world-making. British science, however, still adheres to the nebular hypothesis of Laplace, in its tottering condition. But before it became so ruinous as it now is, the German astronomer Gruithuisen suggested a slow, gradual manner of making this earth. In comparing the two theories, we come upon the national characteristics of the theorists. Laplace began with an impulse without a cause, forming a molten earth without any known fuel. Gruithuisen brought his unknown dusts slowly together without a cause for their collection. Neither gave the origin of matter; but both seem to have been guided by their own surroundings more than by any certain knowledge of the subject. Each has many believers, but they cannot both be right. A follower of Gruithuisen has kindly given us abstracts of the theory, according to which he built up this earth with a mean circumference of nearly 25,000 miles, and a mean diameter of nearly 8000. The quotations which follow are from the MS. of Dr. E. Gryzanovski:—

I. "The earth, like all celestial bodies, is the result of a gradual agglomeration of cosmical dust. Ever since the primordial disturbance of equilibrium in the universe, matter has and must have continued to condense into particles. The bigger masses must have attracted the smaller ones."

We do not know of any primordial disturbance of equilibrium in the universe, and we do not know of the origin of dust. The fact, however, remains that the nucleus of this earth is composed of what we call dust. We are consequently forced to confess that dust existed, in some shape or another, before the nucleus was made. Certain atoms attract others now, and as the whole earth, where known, has in it more or less magnetic power, we may allow that attraction must have existed in the beginning, and must have aided in the condensation of matter.

II. "The first consequence of mutual attraction is contact and adhesion, more or less superficial, according to the violence of the shock."

The ideal shock militates against the gradual agglomeration principle. This supplied the necessary contact and adhesion. Dust falling gently adheres to our polished surfaces, and becomes cohesive in accumulation and pressure. As the nucleus earth is composed of cohesive dust, we may allow that it acquired its condition without any violent shock. The only violent shocks that we know of as occurring on the surface earth, are produced by falling meteors; but none that are known of were violent enough to produce—

III. "The next consequence—rotation. The position of the axis of rotation and the centre of gravity

depends on the shapes, masses, and position of the two coalescing bodies. If these shapes are irregular, the rotation will tend to restore regularity. The ideal being the spheroid shape. This tendency, though partly checked by the hardness, or inner cohesion of the two bodies, must induce a gradual disgregation in both bodies, apart from the sudden disgregation produced by the shock of the first contact. This gradual molecular displacement, which affects first the interior, and through it the surface of the new body, constitutes its history."

If rotation was a consequence of impact, there was no rotation previous to this action, and the agglomerated mass of dust must have been chaotic. But there had been a disturbance of equilibrium. Rotation and revolution cause our present equilibrium, so that it remains to be explained how it was maintained before the impact took place. If this explanation cannot be given, Gruithuisen's cosmical dust requires a new idea, and his cause of rotation is inadmissible. If the irregularities of the sphere while forming on the principles laid down were to be smoothed away by the action of rotation, how is it that our artificial and natural irregularities are not influenced by it? We have mountain peaks five miles high on dry land; we have many elevated peaks in the sea, notably the Island of Bermuda, the base of which is given with

a diameter about 120 miles, with a mean depth below the sea-level on that line of nearly three miles. This pinnacle has been exposed for an unknown period, not only to the ideal force of rotation, but to the certain forces of water; yet the *Challenger* found it still as an unsmoothed irregularity in 1873. As we have no knowledge of disgregation, internal or external, caused by the rotation of the earth, we cannot accept the third section as in any way connected with the history of the Beginning. Gruithuisen wanted these actions for his theory, consequently—

IV. "Molecular displacement producing friction must also produce heat. Thus every cosmic body becomes a reservoir of heat, unevenly distributed through its interior, but ever increasing—by no means greatest at its geometrical centre, or even at its centre of gravity. For even if the two coalescing bodies succeed in rounding off into a perfect spheroid, so that the centre of gravity would coincide with the geometrical centre, that centre is not the point of maximum pressure or of maximum heat. Pressure and density reach their maximum at a depth of two-thirds of its radius; therefore, if the centre of the earth were chemically homogeneous, its zone of maximum heat would form a spheroidal surface surrounding its centre at a distance of one-third of its radius. But the earth cannot be homogeneous, because the

northern, with its vast continents and high mountains, having a larger volume than the southern hemisphere, must be specifically lighter, and chemical differences involve differences in the generation and condition of heat. This shows that the points of maximum heat in the interior of the earth, far from forming a continuous zone, must be very irregularly scattered and grouped along each radius."

This method of obtaining cosmical heat and igneous action was, we believe, adopted by Mr. Robert Mallet a few years ago. The great misfortune of the theory is that we do not know if the molecular action takes place. We have just assigned reasons why it should not take place under the arrangements suggested by Gruithuisen. We know that displacement happens in sedimentary deposits; we do not know that the friction in these cases produces volcanoes; and we do not know that cosmic bodies become reservoirs of heat at a depth of two-thirds of the earth's radius from the surface. This distance is about 2600 miles below our feet, and though it is arranged that heat may run up and down the radius at irregular distances, we cannot accept the arguments offered for this conclusion. We are told that the northern hemisphere, with its high mountains and great lands, is lighter than the southern with its great water areas. We are in a better position now than Gruithuisen was to show that the equilibrium of this earth, so wonderfully ex-

hibited to us in all her motions, is equalled by the wonderful distribution of land and water. By referring to the deep-sea soundings of H.M.S. *Challenger*, as published by the Admiralty for private circulation, we find that 227 soundings north of the Equator give an average depth of 1907 fathoms, and 208 soundings south of the Equator give an average of 1642 fathoms. The soundings between England and Gibraltar in the north, and those in the Straits of Magellan in the south, are not included. The deepest water in the north was 4575; in the south, 2900 fathoms. A very irregular bottom was noticed by the *Challenger* between 46° and 64° S. latitude, and the *Valorous* found a similar condition between 55° and 64° N. (*Geographical Magazine*, October, 1875). The deepest soundings in these respective regions were 1860 fathoms north, and 1800 fathoms south. The most northerly soundings, as given by Captain Markham, of the late Arctic Expedition in 83° 20′ 26″, gave a depth of 72 fathoms (chart, *Geographical Magazine*); and M. H. Woodward gives us a chart in the *Popular Science Review* for April, 1877, showing dry land all round the Antarctic, and water all round the Arctic Pole. If Gruithuisen had known of this perfect and wonderful balance of elemental matter, he could not have used the argument for the scattering of heat up and down the radius.

The chemical differences mixed up with the volume

and the density of earth in this section will be noticed presently. We now continue the Beginning. We are told that a relative fluidity of solids secures—

V. "A universality of drop form among celestial bodies. . . . . If the earth is the result of many successive aggregations, it follows that, the first nucleus being formed of small bodies of irregular shapes, the rounding-off process or mechanical liquefaction cannot have been considerable. The rough nucleus revolved, but, long before anything like a drop form was produced, a new piece of cosmic matter came to displace its centre of gravity and its axis of rotation. The rounding-off labour had to be commenced again, and in a new sense. Thus it must have happened that many interstices and clefts were covered or bridged over by new matter without being filled up, and it is highly probable that the part of the earth which is nearest the centre is its most cavernous and least compact part."

This is a curious passage from the pen of the German astronomer in working out details of his own gradual accumulation of matter. We have a parallel to it from the head of our present Physical School. Sir William Thomson is reported to have told his Section of the British Association at Glasgow :—"We may be quite sure the earth is solid in its interior, not absolutely throughout its whole volume, for there

certainly are spaces in volcanic regions occupied by liquid lava; but whatever portion of the whole mass is liquid, whether waters of the ocean or melted matter . . . . these portions are small in comparison with the whole; and we must utterly reject any geological hypothesis, which, whether for explaining underground heat, or ancient upheavals, or subsidences of the solid crust, or earthquakes, or existing volcanoes, assumes the solid earth to be a shell of 30, or 100, or 500 kilometres in thickness, resting on an interior liquid mass." Sir William spoke confidently of the interior condition, having first acknowledged that he knew nothing below "one kilometre." Relying on the hypothesis of Laplace, he discards the "*interior liquid mass,*" which must be there, if the nebular theory is true. Gruithuisen, relying on the mechanical results of his own ideal, produces heat in the unknown interior by forces dependent on his theory alone. These hot places are 2000 miles and more below us, his hollow places are more distant still; he gets his heat from the supposed falling together of these hollow places; but Sir William infers hollow places from volcanic action, and fills them with *molten lava* or *water of the ocean.* Let us see how Gruithuisen fills his.

VI. "Theoretically the remainder of the earth must be more compact, its ever-growing bulk enabling it

to approach nearer and nearer to the drop form. We do not know how often or at what irregular intervals the earth was interrupted in its process. The probability, as well as the irregularity of these interruptions, justifies the belief that the whole interior of the earth (with the sole exception, perhaps, of the zone of maximum pressure), is full of hollow places, sometimes isolated, sometimes connected, all filled with gases or water, or emanations from surrounding rocks."

The German again loses his point of gradual collection, and refers to unknown interruptions in the making of his world, where no interruption could have taken place, if made by the coming together of cosmical dust from a universal disturbance. He had seen hollow places—there are plenty of them in the hills of Germany and Austria. He did not know much of the erosive action of subterranean waters on the sedimentary deposits of earth; but finding the hollow places in these deposits, he assumed that they must also be in the interior nucleus, of which he knew nothing. The filling of these imaginary hollows with gases, water, and emanations was the natural result of a limited experience. Gruithuisen contradicts himself, and the two philosophers contradict one another; but as neither of them knew anything of the interior, the contradictions are the almost necessary results of ideal explanations of the same phenomenon.

We now plunge into deeper water.

VII. "The earth attracted and assimilated not only solid bodies, but watery ones. The first water forming a primordial ocean found a very rough and irregular surface for its bed. It covered the whole . . . . and stood many miles higher than the highest peak of the Himalayas. In the initial irregularities of the water-bed is the true cause of the existing irregularities on the surface of the earth."

It will be shown presently that water could come without the attraction supposed by Gruithuisen; but we must return to this section again.

Gruithuisen required deep water to account for—

VIII. "Certain complete crystals . . . . and for boulders strewn on the plains around the Baltic; and having discovered that granite would remain suspended in sea water at a depth of fifty-two miles, he did not hesitate to accept such an ocean."

Dr. E. Gryzanovski is puzzled here, and asks, how could such an ocean disappear; the ideal replies:—

IX. "The process of aggregation going on throughout the universe, solar conflagrations must have been as frequent as planetary and cometary collisions, and their conflagrations must have been quite sufficient to deprive the earth and the other planets of any amount of water."

One monster ideal swallows another. Whatever

the earth may know of local accidents now, we are not aware that it ever suffered from celestial conflagrations or collisions. Crystals do not require deep water for their formation, though some of them have been long in forming. The boulders on the present surface of the earth were not deposited by the water that surrounded its embryo. The water of the earth is not taken away from it now, though it may be transferred from one part to another. We know nothing of any water ever having been taken away from it without an equivalent return. We allow that the ocean level was once higher than the Himalayas are now, but we do not require an ocean of water fifty-two miles in depth to satisfy any of the requirements of earth.

Dr. Gryzanovski thinks that "this theory contains much that may appear fantastic:" he believes in its essence. We put it down as an ingenious theory of a human being, on a par with the fire universe of Laplace, in which that astronomer did not entirely believe; and as on a par with the forty-thousand-mile-high mountain, which, believed in or no by its author, Buddah, has been accepted by millions as the hope of their morality and the summit of their ambitions. Man is always credulous—never more so than at the present moment; and if a tale is told with authority, few stop to probe its truth.

The MS. before us goes on with interesting details of earthly phenomena; they do not belong to the Beginning, but we hope to return to them. We have now to see what portions of these opposing theories will so amalgamate with recent discoveries, and known laws of Nature, that all may fit together in one harmonious system, as far as it goes. It is possible that we may add one more link to the never-ending chain, assisting others to go on forging link upon link, till the final ring of the great far-off Beginning may be riveted on to the complete circle.

Two eminent astronomers publish to the world their ideas of world-making—one makes a molten earth, the other a cold earth. They cannot both be right. One formed his world by force, one without it. One earth was formed rapidly, one slowly; the latter by a German, the former by a Frenchman. Both have their disciples, but English science believes in the latter. We call the theory of Laplace "the Nebular hypothesis," and that of Gruithuisen "the Aggregation theory." Neither gave the origin of matter; one calls it dust, one a nebula. As far as our means allow, we wish to discover the condition of matter previous to the construction of this earth, as well as the manner of its construction. The subject resolves itself into two simple questions—First: What was the previous condition of the material used

in the construction of this earth? Second: How did this material become consolidated into the nucleus of this earth?

First. Looking to that part of the earth's surface with which we are all more or less acquainted, we find that it is composed of hard or soft materials, representing compositions of organic and inorganic dusts, and containing minerals and metals. These materials were left in their varied formations, as sedimentary deposits by water, or as wind drifts. Except as bones, shells, and some perfect vegetable fossils, we find no formation in any way identical with the organic remains that formed it. Under the influence of air and water, heat and cold, all organic matter undergoes decomposition and chemical changes. Organic and inorganic formations undergo another great change by the percolation of water through the mass, carrying with it certain soluble portions from one part to another, so that some parts of a formation may be changed by the loss of original material, while other parts are changed by the addition of its own constituents, or by other matter brought in by water. In whatever condition we find materials, organic or inorganic, we know that they must have had an origin. Our organisms are supposed to originate in air, water, and dust; they return to these elements again. As far as man knows there was a time when no organisms

existed. It is commonly supposed that the first germs were nourished and matured by the inorganic elements of earth, in their trinity, under the influence of light and heat. In the organisms thus produced, we do not recognise inorganic matter, otherwise than by analysis; and, in the inorganic materials of earth, we cannot detect the germs or the direct origin of the organism. We know that the materials of earth are constantly changing their apparent conditions, and that specific organic dusts are mingled with, and lost to sight amidst the materials around them, as thick vapours are lost in the surrounding atmosphere.

In this perpetual change we need not suppose, that the nucleus earth represents to us now the visible condition of the material from which it originated, any more than the complete creature represents to us the liquid of the womb from which it came. As far as man knows, our primary rocks are composed chiefly of silicious material of varied aspect. They give evidence in their formations of external forces acting on correlative matter. As the matter and the forces varied, so the condition of the mass varied in hardness or softness, in fracture or cleavage, in retention or non-retention of water or gas. Under manipulation this primary rock is convertible into dust, mud, metal, ashes, and vapour, or many other things. In these changes the natural constituents of the mass become

separated, the solid parts tell of the materials which belong to dust; muds and vapours reveal the water and the air. If we continue these manipulations and examinations we extract coloured vapours from known materials; even when these materials are not visible to the eye, careful analysis detects them, but man has no means of analysing so carefully as Nature. The spectrum analysis has disclosed this faculty in the celestial atmospheres that are occupied by vapour lines, giving out the colours of known materials. From these facts we infer that celestial bodies are composed of materials, similar to those of our earth. It has been shown that these vapours are composed of varying ingredients, much in the same way as various ingredients are found in the strata of this earth. If these vapour lines in the celestial atmospheres emanate from the bodies enveloped by them, then those bodies are formed from materials that can be vapourised; or if those bodies are formed from the vapours that surround them, the vapours can be consolidated. In either way we get evidence that vapours and bodies are closely related to each other. We may therefore assume that this earth, being one body of our solar system, may be composed of materials that were previously in a vapoury condition. As far as man has yet gone into these subjects, this deduction is fair and clear, enabling us to reply to the first question—

The previous condition of the material used in the construction of this earth was vapour.

We may consider this vapour as equivalent to the nebula of Laplace, and as containing in it air and water, divisible from the more solid material the equivalents to the dust of Gruithuisen.

We now come to the second question, How did this vapour become consolidated?

The answer is to be found in existing laws acting on existing elements. It has been lately argued that the laws of Nature are not the same as they once were; but as no new system has been suggested, we must adhere to the old. All that we see or know of give evidence of one continued certain system of cosmical law: the forces and the composition of matter change, but the law does not change. In a late lecture on Science, Professor Tyndall asked—"Has this uniformity of Nature ever been broken? . . . . Not to the knowledge of science!" (*The Mail*, 3rd October, 1877.) As this earth is, then, ruled by laws as old as itself, from which neither mountain nor molecule can escape, we may infer that the same laws ruled the matter-laden vapour while consolidating into the nucleus of this earth. Looking from the surface earth around us to the lowest deposited stratum, we know that all the materials in that depth were either left *in situ* by animal or vegetable, or

deposited by wind or water. These elements therefore moved before any material was deposited on the nucleus. All the organic dusts contained in those strata were once parts of organisms formed from elemental matter. Matter therefore existed before any organism. We are not aware of the existence of any organism previous to the consolidation of our nucleus. We may consequently infer that this nucleus, formed from matter-laden vapour, contained in itself the materials necessary for the formation of organic structures, having dust, air, and water in their compositions. We know that these elements are in every present organism, as well as in those that were: we know that the combinations of elementary matter do vary, and have varied in all organic structures, and that consequently these elements were the origin of every organic body. We are thus forced into the conviction, that as long as air, water, and dust have existed, so long must the laws under which they now act have existed; and as the nucleus itself gives evidence of formation and consolidation under the influence of elemental action, we have a right to infer that consolidation took place in the beginning exactly as it takes place now. How is that?

If we begin by the consolidation of organic structures, we lead the way to the consolidation of inorganic matter. The seed of a plant throws out roots

and a stem; these are the conductors of moisture from the soil, attracted to the sunlight. Under the influence of warmth the light gases are drawn up through the growing foliage, the heavier gases and the moisture are left, and the plant becomes an organism, consolidated from inorganic elements. The egg of a bird, fish, insect, or reptile contains a more or less liquid material, which, under the influence of external heat, becomes consolidated into the respective organic forms. The womb of the animal contains in it a certain quality and quantity of liquid, which, under the influence of external warmth, becomes shaped and consolidated into the animal form. In the liquid of the womb, the matter of the egg, or the sap of the plant, we do not recognise the consolidated organism; but we know that, under the laws of Nature, condensation, formation, and organism must ensue. These condensed materials consist of varied combinations of elemental matter, all originating, as far as we know, from what we call inorganic matter in a more or less liquid condition.

By transferring the causation of organic structures to inorganic matter, we seem to arrive unavoidably on the cause of consolidation in the beginning. We have to assume, with Laplace and Gruithuisen, that there was a mass of nebulous dust occupying a certain space in the firmament. We assume that this

space was the same as that now occupied by air, water, and dust. There is no occasion to imagine that this nebulous dust was once a part of the fiery mass of the sun, or as originating in an imaginary disturbance in the universe. We assume an independent space for the mass before it became dependent on the law. We are as ignorant as Professor Allan Thomson of the origin of the nebulous dust. As, however, dust, water, and air are all here, it is fair to assume that these elements existed in a previous nebulous condition, put together as the elements of the creature are put together in the egg or in the womb. Having assumed so much of the unknown, we come to the action of the law upon inorganic matter as now going on, to show that air is attracted to the light, that water is attracted from the dust, and dust is here. Between 1870 and 1873 Mr. J. B. N. Hennesey was engaged in celestial observations on the Himalaya mountains at a height of 7100 feet above the sea. The results were given in No. 5, "On the Atmospheric Lines of the Solar Spectrum," published by Messrs. Trübner, London. The observations were made when, "the rainy season having passed away, the atmosphere on these mountains is exceedingly clear, so that the sun is bright even to its setting, and a spectrum may therefore be obtained through a long stretch of terrestrial atmosphere." Differences, however, occurred,

"in certain parts of the solar spectrum," which are ascribed "in all cases to the influence of the earth's atmosphere." As the autumn advanced, Mr. Hennesey found that a "*haze*" rose from the earth before sunset, "which grew day by day in height until it attained perhaps 3° or more above the horizon." Mr. Hennesey called this, "my air wall," giving "a visible connexion between the air lines and the terrestrial atmosphere." On the mountains of Western India this air wall rises higher and higher as the season advances into the hot weather of April and May, so that the sun sinks into the lurid haze early in the afternoon, and sets above the natural horizon as a monstrous red globe. Following this atmospheric phenomenon into our daily experience, we see, under certain conditions of light, the atoms of dust playing in the sunbeams: the same thing happens in our palaces and our cottages. We see the atoms of dust falling around us, and we know that dust has gathered and consolidated over cities in which man once lived. We see the dust storms and the sand drifts, we know that matter falls in rain, that sediments may be found in dewdrops, matter has been caught on sheets of paper raised in the air, so that we may be sure that dust is sustained in our atmosphere, as vapour, as haze, as nebula, or in an invisible condition.

As dust falls upon earth now, the rain and the dew

fall upon it—it settles down by its own gravitation; the sun shines on it, and evaporates its surface moisture, so that, by its natural pressure, by sunshine and moisture, the dust that has fallen either on the surface of dry land, or on the water, eventually becomes consolidated. In this consolidation there are as many varieties of firmness as there are of composition; so that as we look upon the heterogeneous character of the earth, we are inclined to attribute the changes to varied laws; but the great law of heat and light, emanating from the sun, rules our elements so beautifully and evenly, that all the changes we see are due to the correlation of varied materials to the varied forces of the law, and not to any change in the law itself.

The complicated duties of elemental matter may be seen in another light, from "Popular Exposition of some Scientific Experiments," *Harper's New Monthly Magazine* for April, 1877:—"Nature thus furnishes us with a striking illustration of the transmigration of matter and force. Now matter is in the air, now part of a plant, now back again in the air. The same is true as regards the energy with which it was associated. Derived from the sunbeam, it lay hidden in the plant awaiting re-oxidation, escaping under the form of heat or light, and remingling with the universal cosmic force." The same process

goes on with the animal, and so "the same particle is now in the air, now in the plant, now in the animal, suffering a perpetual transmigration." All this is done by law, acting on elemental matter, which is perpetually consolidated, broken up, and again used in reconstruction. Man is scarcely aware that these changes pass before his eyes in endless array. Particles come and go; they belong to the organic world to-day, and mix with the inorganic world to-morrow: the changes are perpetual. The laws are for ever acting, and the elements are for ever obedient to the laws.

Thus we come back to the unknown matter of this sphere, before light and heat had force enough to give motion or energy to elemental matter, while that matter was in its chaotic, motionless condition of inactivity, typified to us by the fresh egg or the incipient womb; the whole forming a colourless cloud of nebulous character, containing within it the germs of a future formation hidden in its filmy dust. Was this the beginning of the now firm earth, which gives us our food to eat, our water to drink, and our air to breathe? Was this nebulous dust consolidated by one great law, acting on agents, which have the power to separate and assimilate, to construct, destroy, and reconstruct, with a ceaseless energy, but with a harmony only to be found in one Almighty, never-failing

rule? Who can say it was not? We dare not say it was! We may, however, say that the atmosphere of this earth does hold, and from its beginning must have held, moisture and dust in one vast embrace. Here we must enter on the ideal. A scanty light and warmth fell slowly, when the nebulous mass was thick and impervious, as Mr. Hennesey's "*air wall*" is now, when light could not shine through it, and the warmth could not penetrate far beneath the surface of the new-found vapour-mass.

The report of the Astronomer Royal on the transit of Venus in 1874, gives the distance of the sun from the earth at "93,300,000 miles" (*Academy*, 20th October, 1877). Were the warmth and light, coming from that distance, sufficient to call the elements of this sphere into action? Were they sufficient to give motion to a nebulous mass, occupying a space of some 8000 miles in diameter, and some 25,000 miles in circumference? Did they cause the mass to rotate on its axis, to revolve in a never-ending course round that distant centre, in perpetual obedience to that visible law? Did that law reduce chaos into order? If these things were done, then the minor actions ensued as certain consequences. The lighter gases of the great mass were perpetually attracted to the centre warmth from the nebulous body, till they attained an unknown rarity—a rarity that lost its power

of refraction, its sense of warmth, and its power of motion on the borders of the eternal ethereal space, where rotation ceased, and air, water, and matter rolled round in ceaseless energy, within the cold embrace of that motionless, lifeless ether, perpetually drawn to and repelled from the light, doomed to those never-ending revolutions which give us our seasons, as the rotations give us day and night. We cannot tell when these actions began, but their beginning was the beginning of the law which rules us now. As the lighter gases rose from the nebulous mass, the heavier atoms perpetually sank towards their own centre of gravity. Thus, with the attraction of external warmth, the atoms gradually lost their correlations in the nebulous mass; the gases assumed the condition of atmosphere and water, the other atoms, deprived of these suspending forces, slowly but surely assumed the condition of solidity. The mass of nebulous dust became more clear on its surface, more solid in the interior. There was a transparent atmosphere, a translucent water; the light and warmth penetrated to the shallow solids, and decomposing and oxidising the atoms, reduced them to a second obedience of water and air. Then came on another series of actions; early winds and waves, with initial currents, on an unbounded water, moved the decomposing beds from one place to another, the

ever-undulating waters made an undulating bed; the waters filled the lowest levels, and left the higher levels to form the beginning of dry land. The law still prevails, and these actions still go on. Did they begin as we suggest? We scarcely expect a dogmatic negative: we cannot give a dogmatic yes. The answer to the second question may, however, be given.

The nucleus of this earth was consolidated, because the gases and the moisture were gradually attracted, and separated from the nebulous mass, while the heavier atoms, slowly but perpetually subsiding to their own centre of gravity, became the solid nucleus of this earth.

The Beginning, thus presented to us, is not yet ended: the light and warmth are here, and all the elements of earth obey their laws, while they feel them, and are inactive without them. At a distance of 4 or 5 miles above the sea level, vegetation and life are almost extinct on dry land. At a depth of 4 or 5 miles vegetation and life are nearly extinct in the water. The fauna and flora of this sphere flourish in a sun-warmed belt of 8 or 10 miles deep, leaving a surface margin of 600 or 800 miles unoccupied in the Arctic and Antarctic regions. Our atmospheres are purified and rarefied now, moisture is evaporated and mixes with the air, it is condensed

in cold, it falls, and is again evaporated, and separated from the dust of earth by warmth. May we not glean from these facts that the sun is now, and ever has been, the ostensible lawgiver and the moving cause on earth? We may go farther than this, and say—The three elements, dust, air, water, are kept separate and distinct by the continued action of the sun, and by their own obedience to the law. In this obedience they become one cosmical trinity, acting together in wondrous harmony and unbroken consistency, so perfect and so intelligible, that while the earth's elements continue as they are now, and as they have continued through many millions of years, with the sun of heaven giving its light and its warmth unto them, we cannot imagine a break in cosmical order in the future, or back to the beginning.

While thus tracing the inevitable action of cosmical laws, we have before us a dry land full of the dusts of organic forms, passing through grades and strata, their only record. Those forms grew or lived, they breathed the air, they drank the water, and were nourished by the earth; there is no date of beginning or ending of many kinds. At last we come to man, who proclaims his reasoning soul: he has no date of his own beginning; he does not know the origin of organic or inorganic matter any more than Charles

Kingsley's "shepherd boy,"* the President of the British Association, or King Solomon. Yet every organism is a type of the cosmical trinity, produced from what we call inorganic matter by warmth and light. We can get no further; we do not know the origin of light, of warmth, of life, of growth; but we know they are inseparable; and so we believe that energy and motion had a beginning in the *nebulous dust* of Laplace and Gruithuisen, at the moment when the mass first felt the influence of light and warmth.

We have not answered the question in the first sentence. We have pointed out how the laws of the present act on present elements. We have claimed for these elements and laws an inseparable beginning. We have shown how the air, the water, and the dust are separated from one another to perform their distinct elemental functions, and are again united in the cosmic trinity. That trinity was in the nebulous dust, in the matter which first came under the law. We cannot tell the origin of the law, or the origin of matter. The great problem is still unsolved. How did the Beginning begin to be?

Until that question is answered truly, all our so-called natural and physical sciences, dealing with the

* "Lessons in a Gravel Pit."

Beginning, or with structures rising from a supposed Beginning, must be ideal. Every present doctrine on these subjects varies with the Doctor, following the example of the widely-varying teachings of Laplace and Gruithuisen.

May we conclude the subject with a word of warning to the public. If there is any truth in what we have written, we come to a point beyond which we cannot see, an utter ignorance of origin. The materialist endeavours to trace all things, even the reason of man, to matter; in doing this, he does not know what matter is: till he knows this, he teaches falsely. When he can tell us the origin of our elemental matter, it will be time to argue the question—God, or no God? Till then, we will believe in the God of our forefathers; in the sun as His agent in our solar system; and in the elements, as ordained by Him to be subservient to His laws from the Beginning to the end.

CHAPTER IV.

THE SEPARATION OF THE ELEMENTS.

"O whither will this mad-brain world at last
Be driven? Where will her restless wheels arrive?"

QUARLES.

SECTION I.—We human beings live on a sphere of matter called the solid earth; we are maintained by using its produce as food, its liquids as drink, its air as breath. We feel and see these as separate elements, we reunite them into one body. It is supposed that there was a time when they were in one chaotic mass. Man has been much occupied in tracing the origin of these elements; he has not yet discovered how they came to be; but it seems as if the time had now arrived when suggestions may be made, which will lead eventually to the long-sought goal.

It has been shown in other places, that Laplace and Gruithuisen made their Beginnings from nebulous masses. Mr. Proctor has confirmed this theory, and Mr. J. W. Dawson tells us in his new work, "The Origin of the World according to Revelation and Science," p. 105, "*There was a vapourous or aëriform mass mantling the surface of our nascent planet, and*

without was the darkness of space." We accept this general opinion, and begin our little history from a nebulous mass.

It is supposed that this nebula occupied a place in the ether of space—the intangible, the invisible abode of all heavenly bodies. The origin or condition of this nebula has not been determined; but, reasoning on present conditions, it seems safe to infer that it contained in the mass the bases of those elements which we see or feel, and which are now essential to all existence.

SECTION II.—If we can look at things we do know, we may possibly discover things that we do not know. There are many organisms around us in the animal and vegetable kingdoms, all of them are composed of air, water, and dust; each organism has its own special adaptation of these elements, and, under varied conditions of light and heat, the varied combinations accept varied formations. Gaseous liquidities, or nebulous conditions, become quasi-solids in organic forms. These forms are finite, returning, in different periods of time, their component parts to the elements from which they came. We do not easily distinguish the different elements while in the organism, but we recognise them in altered conditions, while their organic structure is undergoing the process of decomposition.

Following this clue, we do not recognise in the individual air, water, or dust, the condition of a nebula; but we see in their combinations and decompositions certain nebulous conditions. Every organic structure is formed from a quasi-nebulous condition of elemental matter, with an external covering, and an internal quasi-solidity of body. We see in these changes the transformation which took place in the primordial nebula as it came under the influence of law and order.

The ordinary condition of elemental matter is always before us, existence depends on that special condition; slight alterations in either element are destructive to the vegetable and animal kingdoms. If we accept the geological dogma, that there was a time when neither kingdom existed, it is a natural inference that the elemental conditions were not adapted to maintain them, but were in a cold, barren condition. In our subterranean excavations we release gases that destroy life, we find bitter waters and poisonous earths. There are areas of barren unproductive lands and waters. Where the conditions of air and water permit it, these barren spots can be made productive. The poisonous earths can be made innocuous, the bitter waters may become sweet, and the gases may be rendered harmless. Man does these things by artificial measures, Nature does them by

sunshine. It is generally allowed that evaporation is due to warmth, and that the moisture evaporated from solids or liquids becomes pure, or modified. The condition of the air we breathe is produced by the sunshine, the water we drink has been evaporated by warmth, and the produce of the soil that we live on has grown under the sun, with the three elements combining in the production. There are then three conditions of elemental matter, all capable of being combined in one organic structure, all prepared for the combination by sunlight, the structure itself becoming obedient to cosmical law during its existence, and returning its quasi-solidified constituent parts to the air, water, and dusts, when that existence is concluded: all these processes are carried out by elemental forces under the great cosmical laws.

SECTION III.—The laws and forces alluded to may be briefly explained here, premising that we only touch on such mechanical action as refers to our subject, and that we have nothing to do with chemical conditions.

First. The Air.—The invisible elastic envelope of this sphere; it expands by warmth, and contracts by cold, it becomes a force under these influences, and exhibits a universal system of circulation; it is also an individual elemental force by its innate pressure or gravitation. This pressure decreases with height, till

it is supposed that it reaches the rarity and lightness of ether, at about fifty miles above the earth's level.

Second. Water.—The transparent fluid that surrounds and permeates through the solid earth. It expands by warmth into a lighter liquid, and also by cold at 32° F., in both cases it is lighter than the surrounding water. Under these influences it becomes a constant circulating force in surface and bottom currents. In addition to these great motions, the flux and reflux of the waters round the shores, twice in twenty-four hours, said to be caused by the attraction of the sun and moon, possibly influenced by the general motions of the sphere, and acted on by the motion of the winds, is a general and constant force. As the winds move the surface waters, waves, currents, and gathering of the waters take place; all are forces, all aid the mechanical actions initiated by the pressure and gravitation of the element.

Third. The Dusts.—Molecules, or atoms of quasi-solid bodies, all individual forces under the great law of gravitation; all liable to be evaporated by warmth, or to be dissolved by water, to be blown by winds, or to be moved by water in all conditions, in all cases becoming relative forces to correlative elemental action.

We have thus individual and combined forces in our cosmical elements, acting under the cosmical laws of attraction and gravitation. These laws and forces

enter into the composition of all organic structures. We do not easily recognise the normal conditions of air, water, or dust in their altered forms, yet every structure contains in its body varied proportions of these elements, put together with such a beautiful adaptation of heterogeneous matter, as to form an apparent homogeneous whole. It has lately been asserted that all organisms are formed by accident; coming from scientific authors, these assertions become very dangerous to science. Projectors obtain a certain degree of credit, interested or thoughtless men repeat the assertions as facts, and thus discredit is brought upon hypotheses, part of which may be true. As long, therefore, as there is a doubt on a part, the student of Nature is bound to reject the whole, and to accept the safer postulate, all organisms are formed by law.

SECTION IV.—Before applying the law to the far-off nebulous elements of the Beginning, it will be right to examine shortly the conditions under which natural laws act on matter, when it comes under their creative influences.

There are upon this earth elevated regions, and great areas round the poles, where ordinary organisms neither live nor grow. This barren state is attributed to excessive cold, caused by the absence of the sun, or the rarity of the air. Some organisms seem to be

found in the waters at all depths, and in the greatest cold. The comparative barren condition is attributed to excessive cold and partial darkness. Thus the absence of sunlight and warmth causes an absence of organic structure.

In opposition to this state of things, we find the most luxuriant and abundant life and growth in those regions where the light and heat of the sun are most constant. In other words, elemental matter does not amalgamate into structures without certain conditions of warmth and light. It seems, therefore, that all initial motion is caused by the direct or iudirect action of an external force acting in correlation to the matter moved. Whatever form is produced by this force, it is brought to maturity, and continues in existence, by the direct or indirect use of other structures, which have been produced from the elements under the same forces of light and heat. These conditions constitute the law under which organisms are formed.

We have then a certain law acting on certain elements, in certain places, and under certain conditions, forming certain structures, all of which in time return their materials to the elements from which they came. This returned matter is liable to be again acted on by the same laws and forces, and to be used again in the same or in other structures, bound at all

times to obey the law. As we have no proof that this law has ever been broken from the moment of its first action, and as we know nothing of the production of organisms without law, we are bound to believe that light and heat, forming the law of attraction, existed before the formation of organic structures.

We thus come to the consideration of the cosmical body called earth, consisting of the same elements from which its organisms were formed; separate in parts, each part capable of separate action, under different forces, and all capable of combined action under universal laws. This body is supposed to have had a beginning. As far as we know its previous condition was nebulous, embracing in its gases, its vapour, and its matter the bases of our atmosphere, our water and our dusts. The question before us is—how were these elements separated from the nebula?

If this mass of nebulous matter floated in space, suspended in, and surrounded by intangible, invisible ether; we may suppose that the mass was in an adhesive or connected condition, and that this body was in a perpetual state of gravitation. Under ordinary circumstances atoms gravitate to their centre, but this nebulous mass may not have had such a centre of attraction—if, as Mr. Dawson tells us, *space was dark*. The gravitation then must have been aimless and endless. It is assumed now that light causes

attraction, so that, previous to the perception of light by the nebulous mass, the gravitation was taking place through space without a guide. If it is true that this sphere is retained in equilibrium by its own gravitation, and the counteracting attraction of the sun, we may assume this force arrested the gravitation as soon as its influence was felt. If so, we have the original gravitation still in force, but instead of being aimless it is now only endless, for the force is restrained or confined to its orbit round that centre of light and heat by which its aimless gravitation was first arrested. As rotation on its own axis must have been simultaneous with the arrest of aimless gravitation, it seems that as these actions are going on now, they must have been the beginning of this globe.

In the moment when these two actions began, the entire nebulous mass accepted a law, by which its condition was eventually changed throughout. Its shape became spherical, or in the drop form, as Gruithuisen expressed it. The days, nights, and seasons began; and notwithstanding the dogma of Mr. Dawson at page 200 of his book, above referred to, "that there had been no distinct seasons, nor were the limits of days accurately defined," it is difficult to comprehend how these definitions and limits were not as perfect as they now are, as soon as light and heat

provoked attraction, and the cosmical motions began. It seems to be certain that under the assumed conditions of cause and effect, days and nights, summer and winter, must have followed one another in exactly the same beautifully defined order as they now do.

SECTION V.—Simultaneous with these first acts of obedience, which brought the whole sphere under the influence of the law, other cosmical actions must have been initiated, elemental forces must have been brought into action, molecules must have been left unsupported, and the separation of elemental matter must have commenced. These separations and these forces are still going on. We see and feel them daily and yearly; but man has not yet connected them with the beginning of his sphere.

The extraordinary regularity of action, the harmony of cosmical results in days, nights, seasons, and cycles, the limits assigned to the elemental forces, as agents of the law, seem to be in themselves convincing proofs of the certainty of law, and however varied the results may be, there is no difficulty in tracing all the mechanical actions to one mechanical cause.

The great actions before us are attraction and gravitation; the great results are the division of the nebulous mass into the separate conditions of air, water, and dust. The minor actions are those effected by the elements, as agents of the law, in moving and

distributing materials placed at their disposal. The origin of all these actions seems to be the sun.

These cosmical actions are so united in universal harmony, and approach each other on such invisible horizons, that their precise limits are undefinable. By again glancing at what we know, we may get glimpses of what we do not; we may see the effects of attraction on the gravitation of matter, though the origin of that matter may be still undefined.

The vegetable world around us offers samples of attraction by light and heat; germination begins by external heat acting on internal moisture. Small fibres are thrown out, within them are minute highways; the moisture of earth is attracted to the surface through them, the germ springs upwards and assumes its character; little leaves shoot out, the moisture is attracted to the extremity of each, some is drawn through their invisible pores to mix with the vapours around them, and they in the sunlight inhale the gases of the air through those invisible pores. These gases and the moisture, combining in the organic structure, undergo a natural transformation, the lightest molecules are drawn to the exterior by the attraction of warmth, their vapours are taken from them, and the molecules gravitate into the tissue, the rind, or bark covering of the individual; beneath these coverings the liquid sap passes up, and from this

the body grows higher and higher, till the structure is completed by the gravitation of matter; from this gravitating mass the force of attraction still draws out the bud, the flower, and the fruit, within which the final effort of attraction slowly gravitates into the perfect seed. The gases and the moisture of these structures represent the nebulous condition from which the sunlight attracts the lightest gases, and the lightest liquids, leaving the heavier liquids to combine with their assimilating gases, and the solid molecules to complete the structure.

In all these samples we come to undefined horizons. The eye of man cannot trace the end of attraction, or the beginning of gravitation. These may vary in every structure, but the mechanical actions go on for ever. The light and the warmth for ever attract the lightest, and for ever leave the denser molecules to gravitate into their respective solidities. The structures may be short-lived or long; they obtain repose during night, and in the winter, and when the natural period of life is ended the leaf withers, the branch decays, slowly but surely the energies decline, the highways in the fibre close up, attraction no longer is attended to, and the whole gravitates in decay.

Attraction is thus a force correlative to the matter attracted; when the correlation ceases gravitation ensues. If heat and light are the sources of attrac-

tion, the force must vary with its ever varying cause; consequently, no two organic structures of the same kind are identical in size or condition. We may assume that the supplies of gases and moisture were equal in the same place, but the constant change in the external force of attraction necessarily acts on the internal force of gravitation, showing that the one must be dependent on the other.

A similar process goes on in the animal kingdom. The germ begins its existence from or in a quasi-nebulous condition of matter, in an apparently heterogeneous condition; under the influence of external warmth a quasi-solid homogeneous condition is assumed, and from this is attracted to the surface certain light molecules, which form the outer covering of the creature; while this is going on the formation of the organism becomes complete, and it is born, or hatched.

The cause of attraction in the animal varies from that in the vegetable kingdom. This is direct: the other indirect. The creature obtains warmth by consuming the vegetation, in which the requisite quantity of sun warmth is retained, and with this indirect heat the process of regeneration and completion is carried out through the same channels of attraction, gravitation, and consolidation.

SECTION VI.—Under these laws, forces, and actions,

every organic structure is an epitome of the sphere on which it exists. Keeping in mind how the great forces are thus brought into action by the direct and indirect influence of the sun, operating on gases, liquids, and atoms in nebulous conditions, and producing from them quasi-solid formations, holding in their bodies atoms, liquids, and gases in altered conditions, we may now reapproach the vast nebula of the beginning, with some prospect of comprehending how its elements became separated.

The diameter of this earth is said to be 7876 miles, the distance from the sun is about 92 or 93 millions of miles; we have no knowledge of any light or warmth impinging on this earth from any other external body, unless it may be from our satellite the moon, and as the light from that body is a reflected light from the sun, we may say that our only sources of light and warmth are direct or indirect from the sun. We do not mention planets or stars, as the influence of their light cannot be reckoned in the actions of the beginning; as all the present mechanical forces of this planet can be traced to the direct or indirect influence of the light and heat, as these influences must have operated from the moment they were first felt, and as the first consequences must have been a general action over the whole surface of the nebula, the secondary consequences must have

been a general action on the molecules comprised in the nebula. As the molecules in an egg remain idle and inergetic till they feel the influence of external warmth, so the molecules of the nebula were idle till they were called into play by the influence of the distant sun. As every molecule that now falls under the correlative influence of light and heat must perform the duty required of it by that correlation of force, so in the beginning the lightest molecules were attracted to the surface, while the heavier molecules, which had previously been held in suspension by the lighter, began to gravitate as soon as their support was gone. A great result must have been soon apparent. The light gases rose towards the sun, the denser gases remained below them, till becoming denser and denser, as the light were perpetually drawn from them, a liquid spread itself between the volatile gases and the gradually gravitating solidifying molecules. This liquid assuming in time the condition of water, and the denser molecules the condition of solid land or rock.

The initial, the progressing, the still continued, and apparently the everlasting law of Nature, with its ever-acting forces and its elemental agents, are thus brought into a condition similar to that required by Cailletet and Raoul Pictet, in their artificial reduction of air and its gases into liquid. This event was noticed in *The Academy* of 9th February, 1878:—

"M. Cailletet, in the last week of November, announced to the Academy of Sciences, Paris, that he had reduced nitrogen dioxide to the liquid state (under) a pressure of 104 atmospheres, at 11° C. On December 2nd, he had succeeded in liquefying oxygen and carbonic oxide, under a pressure of 300 atmospheres, and at a temperature of $-20°$. On the last day of the year he subjected nitrogen to a pressure of 200 atmospheres, and obtained liquid drops of that element; 'air also was subjected to experiment,' and a jet of liquid air issued from the apparatus."

Raoul Pictet, of Geneva, "closely following the French discoveries, on the 10th of last month (January, 1878) successfully demonstrated the liquefaction and solidification of hydrogen . . . . the liquid was blue, and the observer saw a hail of solid particles projected violently to the ground." We took the liberty of asking M. Pictet as to the quality of the liquid thus discovered; he forwarded in reply his very interesting, "Memoire sur la liquefaction de oxygène, la liquefaction et solidification de l'Hydrogene;" but the quality of the liquid is not defined. As M. Pictet promises to complete the history when he is furnished with new material, we may hope that this point will not be omitted.

If liquids and solids can be expressed from pure air, and from its separated gases, under the influence

of cold and pressure, we may imagine how much more simple a similar operation must have been for Nature, before the sun had dissipated the cold of primordial darkness on the new-found nebula to express from its gaseous, moist, and molecular mass those elements which were necessarily expressible then, as they are now, and thus liberating those moistures upon which the influence of the growing light was at once felt. This influence is still here, still drawing the gases and the vapours upwards, still rarefying the air in its cold upper regions, still condensing the moisture and letting it fall in dew, or rain, or snow, or hail, and still exercising its influence on quasi-nebulous matter in the vegetable and animal, to produce the quasi-solid animal or tree in uncounted organic structures, but each one embracing, in its form, gases, liquids, and solids, all to return to the elemental conditions again in never-ending cycles of life and death.

If this sketch of action is true to Nature we can see the entire nebulous mass of the beginning coming as it were to life. Embracing in its constitution all the gases and the bases of all solids, the whole of which are now more or less susceptible of the influence of light and warmth, it would have been strange if those influences had not been felt then. There was, therefore, a perpetual refinement of the outer circle, that portion more exposed to the action of the sun, a

perpetual liquefying of the next circle, less susceptible of heat and light, and a perpetual condensing of the inner circle by the attraction from it of gases and of liquids, thus being left to its own law of gravitation. There were then attraction and gravitation perpetually at work, both tending to reduce the apparent heterogeneous nebula to the quasi-homogeneous conditions of air, water, and dust.

SECTION VII.—We have now reached the point at which the nebula of the beginning was feeling the effects of law, light, and warmth. The results of the law were similar to those felt in every womb, in every egg, in every plant; attraction, separation, condensation, and gravitation, all progressing at once; elemental atoms in the entire mass moving, changing, and reforming under one great cosmical law.

We must look a little at these actions separately and jointly, dividing them into their respective and separate heads.

First.—We have no means of knowing the condition of the temperature, or any part of the nebula, when action first commenced. We do not even know the condition of light, or whether the nebula was more or less sensitive to light, warmth, darkness, and cold, than the earth, the water, and the air are now. All we know is, that the law must have been felt before its action began. From the moment of the

first impulse we may suppose that evaporation took place; with this action there must have been expansion in the sunlight, and contraction in the darkness; with these two actions by day and night, in summer and winter, a circulation of atmosphere commenced all round the sphere. As the lighter gases continually rose upwards, and as the heavier gases subsided, the element became more subtle, more refined, and more susceptible to influences; it became, in fact, the great elemental force called wind. As soon as the atmosphere began to move under its own laws of expansion and contraction, it became more and more susceptible of light. Molecules were disentangled from the vapours, vapours were blown about and cleared away, atoms were continually moved on, and continually dropped. The winds blew into those places where they were not opposed, and so they carried molecules from the full to the empty places. As the orbit of the earth is and was oblique, passing to the north and south of the line, called the Equator, it followed that half the sphere was in winter and summer alternately; and thus a uniform system of light and heat, of expansion and contraction, of conveyance and deposit of molecules, was for ever going on. We see all these actions going on now. We believe the air, as it is, has been handed down from what it was, and that its actions

are now similar to what they were in the beginning.

Second.—If it is allowed to assume, that the formation of water was simultaneous with the formation of air, it is obvious that the motion imparted to the one must have been felt by the other. And as the gases of the water are also susceptible of heat and cold, it is evident that the whole mass of water, occupying the space between the air and the consolidating body below, must have been liable to two motions: one, caused by its own expansion and contraction, acting on it all round the sphere, resulting in currents above and below, producing a circulation in all depths, and possibly aiding in tidal action; the other, dependent on the motions of the air, producing surface waves, surface currents, and the heaping up of waters, shown to us at certain high tides, and by cyclone waves.

Third.—If the two first formations went on together, it followed that molecules of matter, left unsupported by the air, and the water, attracted from the nebulous condition, must have began to gravitate towards their centre of rotation. Here we come upon a difficult situation. If the initial clearing was caused by attraction only, that force must have acted more upon surface matter than on the interior; consequently, the molecules of solid matter, gravitating

from the surface, must have rendered the nebula beyond the influence of attraction thicker and more impervious to the light and heat; so that, by degrees, a dense mass of molecules naturally segregated round the surface of that thickening interior. The result must have been a sheet or layer of matter deposited on the still nebulous interior.

There seems to be only one way of getting out of this situation, to enable us to accept the dogma of Sir W. Thomson—"*We may be quite sure the earth is solid.*" In the hypothesis of Laplace, the centrifugal action is supposed to throw off rings of nebulous matter; and Gruithuisen imagined that the same action produced a levelling of surface inequalities. If we apply this centrifugal action to the lightest molecules of our nebula, it seems possible that they may have been gradually forced out, and that the more dense molecules found no obstacle to their settling down into a quasi-solid mass.

If this condition did happen, and the centrifugal action was inadequate to counteract it, the solid dogma must be doubtful; though the condition secures an escape for many geologists out of their impossible positions. It has been supposed by many that our mountains have been heaved up by the heat of the interior, or rather by contraction on cooling from that heat; as that heat depended on the

truth of the nebular hypothesis of Laplace, and as that may now be considered untrue, this mountain origin fails; but if the condensing molecules of our nebula settled down on a still nebulous foundation, it seems possible that the superincumbent mass would sink in places into the soft foundation, and cause other places to be upheaved, either by lateral or vertical pressure. It will be difficult to account for these upheavals on areas heavily laden with water sediments; but as we cannot allow of these upheavals, and as we have to touch on the subject again, all we need say here is, that those who advocate these actions are bound to explain their cause.

To continue our history of the more solid atoms, it would seem that while the gaseous matter of the nebula was slowly and surely attracted to the light, as it is to-day; that the heavier portions were perpetually sinking; as these sunk, they may have driven the lighter gases upwards, and caused an exhalation dependent on the slowly increasing pressure, by the continuance of attraction, gravitation, and consolidation. In this way the entire process was one of mutual reciprocity, ruled by the great law of light and heat; acting by day, resting by night, active in the summer time, lethargic in the winter. Thus atoms were at times buoyed up in the force of attraction, at other times sinking under their own weight; now moved on

with vapour, now with water; but for ever losing some of their neighbours by the never-ending law of gravitation.

Fourth.—We must now look for a moment at the joint actions of elemental matter as it became separated. We can imagine nothing but a thick, hazy condition of air, and a muddy condition of water. Our fogs blow off now, and the waters become comparatively clear; but the general nebulous character was not to be lost at once. Light solid molecules are liable to the action of evaporation now, and as the entire mass of the beginning was vapour, its lightest particles went up with the gases, and others remained in the waters. As both moved under these influences, atoms were carried about by each; and as the air drops atoms of similar densities in certain areas now, so it dropped the atoms of its haze in the beginning; scattering the matter evaporated from one over other areas, and drifting like atoms to the end of the drifting force. As water now moves masses by rolling, by suspension, and in solution, so it moved matter then. It was not only the atoms which had never settled down that were in motion, but atoms which had been allowed to settle down under a gentle force, were liable to be moved by a greater; so that, in some region or another, the two moving forces were perpetually occupied with the more solid cosmical atoms.

SECTION VIII.—So far we have only treated of the actions which initiated the different elements in their natural divisions; we must now follow these elements into their own individual actions, and deduce, from the present results of these actions, the unavoidable results that similar actions must have had in the beginning.

First.—The air is called a fluid element; it is subtle, invisible, and elastic. Maunder gives it an extent of about "40 miles above the earth's surface;" others talk of 50, and *The Academy* of March 2nd, 1878, p. 193, in a note on the increase of heat with depth in the earth, gives dogmatically "(60 miles)." With these different opinions we have no dispute; one idea on an unproved point is as good as another, and all we can say of its extent is that it is not yet measured. As far as its actions in its upper regions are concerned, we have not at present much to do; we know that at the sea level its influence is great. In the tropical regions the currents assume a character of great regularity, known as trade winds, blowing from a fixed direction for certain periods. In the temperate and frigid zones it assumes a more irregular condition, with certain currents called equinoctial winds. We have in different regions tornadoes, hurricanes, and cyclones, all developments of the innate atmospheric forces. These have distinct and

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separate dynamical actions on the north and south of the Equator. The general atmospheric action round the sphere varies from calm to storm; it is never entirely at rest. There are several strata of air over our heads, some may move one way and some another, and in certain latitudes the winds blow from the sea during a portion of the day, and from the land during the other portion for certain periods of the year. The air is said to be composed of nitrogen gas, four-fifths, and oxygen about one-fifth. It contains also small portions of carbonic acid and hydrogen gases; our senses tell us of the presence of these and other gases, but the general and never-ending circulation of the air rectifies and purifies the entire body. The expansion of the air is gradual and imperceptible, the contraction begins in the same way, but the results of both may be visible, forcible, and sudden.

Second.—Water is a fluid composed of two gases—hydrogen about two parts, oxygen one; it is now transparent, and without colour. The great body of water is salt. Lakes, rivers, wells, give fresh water impregnated with such minerals or metals as may have formed its bed or channel. Some of these water springs are warm, caused it is supposed by the sedimental matter through which they may have passed. All these fresh, hot, mineral, or metallic waters seem to be due to the rainfall, and therefore to evaporated

moisture; hence we may infer that all waters were made salt in the beginning, and only that which falls under the influence of light, heat, and evaporation, becomes fresh. The great waters have actions of their own in great cosmical currents, dependent partly on the centrifugal action of the sphere, partly on the expansion and contraction of the element under the influence of the sun. All surface waters have action dependent on the winds above them. Surface currents are thus made, waves are raised, waters are blown together, and then fall apart, so that, with these two causes, the indirect and direct action of the sun, a complete circulation is produced over the entire surface of all waters, and down to the lowest depths of the great ocean.

These depths are very important to our history. A few years ago the ascertained depth was 7200, the *Challenger* found 27,450 feet; but this depth is small to that discovered by the Geological Survey of the United States of America. We refer to the "Report on the Geology on the Eastern Portion of the Uinta Mountains," by J. W. Powell: Washington, 1876; one of the most complete and exhaustive records of any area of earth's surface ever made. In the first page of the Preface we find "an aggregate thickness of 50,000 feet" of sedimentary formation, embracing groups "of Palæozoic, Mesozoic, and Cenozoic ages."

At p. 33, "30,000 feet" of deposits are said to have been denuded and removed. At p. 37, "a general section of the sedimentary beds alone sum up a total of nearly 60,000 feet." At p. 181, "more than 25,000 feet of beds have been removed." If there is now a thickness of 50,000 feet of sediment, and if 30,000 feet have been removed from the surface of that mass, we have a total thickness of 80,000 feet, or more than fifteen miles deep of water, in which these sediments were deposited. We shall find as we go on that this enormous depth is by no means incompatible with the condition of the sphere in its early state, and that present depths of water, and present elevations of land, are natural consequences of primary elemental conditions.

We thus establish a great fact—water deposits prove a vast depth, and a vast force. We have already shown how atoms were liable to this force, but we must revert to the conditions of atoms.

Third.—The atoms of the present moment that come under the influence of water and air, are composed chiefly of organic remains. Some of these are acted on in their first stages of decomposition, others have settled down and amalgamated into beds or formations with other materials. From whatever materials these beds are made, and whether they are made as wind drifts, or water deposits, they become

liable at once to two forces. The deposit under water is for ever pressed upon, or worn away by that element, thus securing two results, one of denudation, the other of consolidation. The subaërial deposit is also liable to water action by the rainfall; with some atoms this results in consolidation, with other atoms it results in denudation in two ways: first it removes some from the surface; second, it percolates others, and removes interior atoms from one place to another. In certain formations this percolating force causes extensive denudation and removal. Previous to the formation or creation of organic structures, and before any of their dusts were placed at the disposal of air or water, these elements were busy with the arrangement of the atoms, or the dusts contained in the body of the great nebula. The deep waters moved them on, the shallow waters broke them up; they were carried from one, and left in another spot; there were atoms in solution, in suspension, and in rolling conditions, all moving on in correlation to the water force. The force and the atoms continually changing in character and condition, here the finest were left in the scarcely moving depths; here the denser were deposited in the gentle moving liquid; here the heavy atoms were deposited by a stronger force; as the winds blew by seasons or by days, so the waters beneath them obeyed their sway; as long as the forces were

correlative to the atoms left at their disposal, so long were atoms dropped along the course, or at the end of the constant or intermittent forces. As the sand dunes in America, Holland, and other places have been raised by the winds, and consolidated by pressure—as the Chisel beach and the Motherbank are for ever acted on by waves and tides—so tides, waves, currents of wind and water with accidental whirls, eddies, and calms, must have deposited their atoms in the first place in vast undulations, while this character of deposit must have been continued.

During the whole period in which these elemental actions have been at work, while atoms were deposited in one place, and removed from another, another action was continually progressing under the special law of gravitation. Geological records are full of subsidences; we see them take place, and we feel their effects, on dry land, as well as in the great earthquake waves of the ocean. The great agent in these gravitations at present is water; it wears away and removes atoms from all formations through which it percolates, or runs in subterranean streams; it removes supports from some, and gives support to other atoms; areas are built up in one place, and subside in another.

Before organic dusts existed, and before the present condition of stratified material offered certain filtration

areas for the rainfall, another natural action took place, by which similar subsidences must have been caused. We have pointed out how atoms of varied density must have been deposited in different places by their correlative forces; that, under these actions, the consolidating atoms must have been of varied condition in many areas; and that while one quality was deposited one day, another quality might have been deposited the next. Every variation in the depositing force made in fact a varied condition of deposit, though the atoms deposited came from the same nebulous mass. These primeval deposits must have varied from the condition of soft mud from solution, into the coarser muds formed from atoms that had been held in suspension, and so on through sands, gravel, shingle, and boulders all deposited by currents correlative to themselves. There were then some areas with firm and others with soft foundations. As atoms were in course of time deposited on all these areas, it followed as a matter of course that subsidences perpetually took place in some places, while others remained firm. These incidents of our early history are still going on, and may be still due to the early soft foundations, and thus, as we have hinted, the undulations of the present are due to the actions of the past.

The great results of these actions now before us,

are oceans of water with an extreme depth of about five miles instead of eighteen, and mountains of some five miles high above the present level of the waters, instead of masses of matter under water fifteen miles thick. The most extraordinary part of the history is, that, as present rivers run now at the foot of these vast sedimental accumulations into the sea, the level of the ocean must be fifteen miles lower than its surface level was then, that is, when the sedimentary strata mentioned by Mr. Powell were deposited. Our horizons in this section have merged into one another in an almost imperceptible gradation, but the zenith clears up with the light of a noonday sun.

SECTION IX.—We see Nature perpetually at work, we watch her actions, and comprehend results; but we have never been able to understand the Beginning, because it has hitherto been set before us on tottering foundations. The whole tendency of science leads now to the true origin of the separation of the elements, and these actions were the beginning of the present condition of this sphere. We do not wish to write dogmatically, neither do we feel inclined to hesitate in our views, but it seems as if there never was a time so convenient as the present for eradicating old ideas, and substituting new ones that rise naturally from the latest discoveries. We have often warned those who meddle with cosmical subjects of the un-

certainty and the inutility of a central internal heat in the earth. Mohr and Dunker gave evidence against it from the investigations in the deep mines of Sperenberg, and now Dr. Hann analyses the reports of heat in the base of St. Gothard, in the *Austrian Journal* of 15th January, 1878, and once more warns science against false conclusions from imperfect investigations. We say again that this heat in the nucleus earth is purely imaginary, that it had its origin in an unfounded beginning of this solar system by Laplace, of which he said: "*Whatever may have been the origin of this arrangement of the planetary system, which I offer with that distrust which everything ought to inspire that is not the result of observation or calculation, it is certain that its elements are so arranged, that it must possess the greatest stability, if foreign observations do not disturb it.*" This theory has been trusted to for more than seventy-five years, many sciences believe in it still. We have shown its instability by its unnatural and lawless system, and we cannot but hope that the evidence, collected from many quarters, may now induce those who believe in it, either to come forward with proofs of its truth, or with a simple rejection of a false and unproved hypothesis.

To resume our history. If we accept an undulating condition of the consolidating nucleus earth under the

never resting laws of light and heat, with the never resting agents air and water as they began to feel the influence of the law, we come upon a perpetually moving scene. The still nebulous mass rotating and revolving, the gaseous matter becoming continually clearer and continually circulating, the denser gases rising surely but certainly from the heaving mass below, slowly but surely assuming a liquid character, and in that condition accepting motion from the rotation, the revolution, the sun heat, and the winds. The denser portions, gradually losing their gaseous supports, assumed slowly but surely the condition of solids, perpetually gravitating to their centre of rotation, perpetually moving under the influence of the liquid and the air, and perpetually settling down by their own gravitation, as soon as the moving forces lost their correlation. In these simultaneous movements the air rested on the water, and this rested on the slowly consolidating nucleus. We can assign no place for the level of the nucleus, or for the level of the liquid; we can only assume that the limit of the air was possibly confined to the original boundary of the nebula. We see no reason for its increase or decrease in an upward direction, but there seems to be a reason for its extension downwards. This reason is founded on the necessary retiring and subsiding of the solids, the consequent sinking of the waters, the constant

accession of the nebular gases from the interior, the perpetual refinement and rising of these gases, and the perpetual filling up of space from which the waters were moving downwards. We know that the waters once rested on the rocks, upon which some of our coal seams are found above the surface of the sea. We know that they rested on the nucleus in the Colorado region, upon which they deposited sedimentary matter between fifteen or eighteen miles in thickness. We know, therefore, that the depth of water extended from its present surface level to a height treble that of our present highest mountains. We know that our ocean now varies in depths, we may conclude that it varied then; but we have no occasion to conclude that the present ocean bed was the ocean bed of the beginning. On the contrary, we may be sure that it was not.

Under the head of "Mountains" and "The Sea Level," in "*The Incidents of Dust*," we have attributed the present condition of the water level and its depth to the certain denudation of the sea bed, and the consequent sinking of the waters into the denuded places. All this retirement of the waters was supposed to be done without any diminution in the quantity of that element. A Dundee paper objected to this, on the score that an equivalent of land had not been thrown up. A similar impression may have been received by

others; but no one knows the average depth from which the waters retired, or the nature of the undulations which then prevailed. The objection from Dundee is therefore without force, and the conditions of elemental matter at the Beginning make our position more secure. The wearing away of the water bed is as certain a fact as the wearing away of the Uinta Mountains, of which Professor Powell remarks at p. 201 of the Geological Report above quoted —"The mean degradation is three and one-half miles, and from the entire area there has been a total degradation of 7095 cubic miles." Under these certain actions and movements, it followed that sediments formed in an early period became degraded, and moved away, so that as Professor Powell says, at p. 205, "Beds of carboniferous age might thus be placed on beds of tertiary age." Thus as undulations have been filled up in the periods of geological history, they were filled up and degraded when the air and the water first began to act upon the nucleus of the earth. There were, however, two other causes aiding to lower the level of the water.

It has been pointed out how, from the beginning of elemental movements, the vapourised, the dissolved, the suspended, and the rolling atoms were lodged in their respective places. The great results were hard and soft deposits. Under the natural course of gravi-

tation the subsidence or the consolidation of these areas was unequal; so that, in addition to the unequal action of the water movements on their bed, there must have been unequal subsidences of that bed. It is quite possible that these initial actions have not come to an end, and that some of our earthquakes and great tidal waves may be due to the continuing consolidation of the great interior body. The result of a constant and long-continued settling and contraction of the nucleus must have been to reduce the general level of the water bed, and its surface, and at the same time to throw up areas in sympathy with those that subsided. To these sinkings and elevations are possibly due the foldings and the crumplings, the faultings and displacings, so constantly alluded to in geological works. It is obvious that these actions must have aided in lowering the water level.

The other cause to which we have adverted above is more complicated and more beautiful. In the early days of evaporation, the condensed moisture returned to the universal waters. As soon as dry land appeared, there was something for the tasteless liquid to do, as it fell in the shape of dew or rain upon the new-found solidity. It was not only liable to be evaporated again as moisture, but channels were found for it to rise through. As this moisture rose above its soil bed, it was liable to gravitation. As the gravitating

molecules met the influence of the external atmosphere, they hardened and assumed the character of a glazed silicious skin. Beneath that skin the attracted moisture (our sap) still flowed upwards through its own made arteries, till it spread from the main stalk or stem into blades and leaves, and flowers and fruit; to constitute that outside covering to the dry land, our vegetable kingdom; varying now from the silex-covered grass to the rough, soft coat of the cork tree, the thorn-covered stem of the bramble, or the irritating armour of the nettle. Every vegetable organism is a reservoir for the liquids of earth; there are some that use salt water, but those that grow on land use fresh. The entire quantity of this has undergone the process of evaporation before it can be thus used. In the beginning this supply was drawn from the great waters, and even now they must supply the largest portion. It is impossible to say how much is taken up and used; but late experiments exhibit a vast aggregate.

Professor Dewar, in late lectures "On the Chemistry of the Organic World," told his audience, as reported by *The Mail*, 18th February, 1878—"16 grains of corn transpire 3½ lbs. of water; a field of wheat transpired, between April and July, as much water as would cover the surface of the ground to a depth of nine inches." It was pointed out how this liquid sap

ascends the arteries of plants at the rate of "24 inches per hour," and that "two hundred times the weight of organic matter elaborated by a plant passes through it in the form of water during its growth." Taking all the vegetation and all the animals now on the face of this earth, we cannot compute the amount of liquid taken from the waters; if we consider the quantity of liquids stored up for the use of man, if we think of the stores laid up in natural subterranean cellars, we cannot calculate the quantity of liquid once taken by evaporation from the salt seas, converted into fresh water and sweet, receiving its flavour from the earth's great filter, deriving qualities from the plants it lives in, and giving to the vegetation and the animal their first atoms of nourishment.

We cannot tell how much liquid is in use, how much has been taken from the ocean, neither can we measure the areas of undulation on the face of solid earth. All we know is, that our highest mountain tops were once under water, and we are told that miles of earth have been taken from these heights; all these masses were deposited by, and removed again, by water or by wind. The work is still going on, so slow, so sure, that we are only aware of them, though we cannot measure the results of a hundred years.

We have certain laws and certain agents by and

under which all the actions and motions of this sphere are controlled, but as no two things of the same kind in Nature are alike, so no two minds are capable at first sight of seeing the whole panorama of this world. If we can allow that the laws, and the agents now before us, were those which initiated and regulated the beginning, we have a glorious picture, perfect and complete in colouring and design, minute in its details, harmonious in its whole. There are lights and shades, clouds and sunshine, indistinct and clear horizons, a bright foreground and a sometimes hazy distance. We will endeavour to produce a brief abstract of the history.

SECTION X.—We have endeavoured to follow the clue we started with; we pointed out the nebula in the egg and in the womb, with the result of external warmth upon them. We have shown the growth within their limits by attraction, and the solidification of their contents by gravitation. We have suggested these as analogies for the beginning of this sphere, from which the egg and the womb originated. We have pointed to the feathers on the bird, the scales of the fish, the hair of the animal, the skin of all creatures, the leaves and the bark of vegetation, as all emanating from the internal supply, by the force of outward attraction from light and warmth. We put these actions down as samples of those by which this

sphere was formed. We see in the air the result of attraction by light and heat on the gases of the nebula; we follow the same causes acting on the water, and we see in the condensing body, on which we stand, the results of gravitation on the matter of the nebula.

If then this world originated from a nebulous condition, and if it was changed into its present condition by those laws which change all nebulous matter now into analogous conditions, it seems as if the system we have laid down must have been the one, under which the atmosphere, the water, and the solid earth, were separated from their nebulous condition. The law for this separation still holds good, the gases are still refined by warmth, moisture is still evaporated and purified, atoms are still left to gravitate. The laws still hold good. The elements can never rest as long as they owe obedience to the sun.

So far may we go—our restless wheels must stop here for a time—we have no clue to the origin of the nebulous mass from which this sphere originated. The entire history of its change, from that to its present condition, relates no accidental but a well-ordered legal process, resulting in a consistent and harmonious whole. Man has tortured a glorious system into a mad unlawful career, forgetting that universal laws

could never be without an universal Ruler. We do not know the origin of that Ruler; He has been handed down to us—from epochs which held as wise men as the present—as *Incomprehensible.* When that term can be controverted, it will be time to think of another *first great cause*—till then, our Beginning is in *the Incomprehensible Creator.*

CHAPTER V.

CONCLUSION.

It seems to be sufficiently shown in preceding chapters, that recent discoveries destroy the nebular hypothesis and the aggregation theory; nothing is left of them but nebulous matter. We have endeavoured to show the results of present laws on that material, as far as certain facts provide the details; we attempt to generalise the position of creation in the following brief epilogue:—

Creator. Go forth, my Light! and from the space around
Gather the wand'ring Vapours to my care;
So shall they add their glories to thine own,
And fill My kingdom with bright worlds of love!

Light. I fly to execute My Lord's decree.
Who wanders there?

Vapour. A vapour, all chaotic, cold, and dark,
Laden with matter.

Light. Turn round, that I may see if this be true.
It is! Wilt thou have light, and warmth, and order?

VAPOUR. Yea, if thou deignest to bestow these things.
LIGHT. The gifts depend upon thyself. The law
Is reciprocal to obedience.
VAPOUR. If to rotate be to obey, I find
It joyous. May there be nought else to do?
LIGHT. Much! if thou lovest our Maker, and His law.
VAPOUR. Oh tell me! what is love, and what is law?
LIGHT. Thou felt'st their impulse as thou turnedst round;
Attraction unto me, thy law of love,
A law to guide thee into light for ever,
Thy matter unto future destinies.
Thine heart, rejoicing in my first warm glance,
Sprung up in love, so will it always spring
In growing grandeur, with increasing warmth,
Thy God will love thee through my inmost light,
And give thee blessings of unmeasured wealth.
And I will glisten on thy teeming sphere,
And draw thy streams of love towards my breast,
Our God will fill them with the breath of Heaven,
To feed thy bosom with the germs of life.
This is the law of our Creator's love.
VAPOUR. Strange! I pray thee say, What then will be?
LIGHT. Happy in our beginning, we will be
Happy in our future, in the guidance
Of one Omnipotent; beneath His rule
Happiness is eternal. If we break

Faith with each other, then we break His law;
Should this be so, I go away, and thou
Return'st to darkness, chaos, and the cold.

VAPOUR. Thou wilt not go! We cannot break the law!

LIGHT. My going will depend upon thyself;
I shall obey the law, and cherish thee.
Thou on thyself rotating, half in light,
Half dark, will then receive thy day and night.
Wrapt up in my embrace, thou wilt revolve
Around me, as thy centre of attraction;
Bringing to thyself the change of seasons;
And thus, in time, ensues our Progeny.

VAPOUR. These are the laws of love!—Our Progeny?

LIGHT. Our end and aim. Thy natural offspring.
Thy varied elements combined in one;
Not as thou lately wast, a vapour cold,
But from that vapour an elected unity,
With many portions, but a whole of none:
Creations of our God, through me, from thee.
While holding strict obedience to the law,
As they begin, so will they continue;
Varying with varied constitutions;
Each, from its birth to death, a type of thee;
Each with its penalty for breach of law.
Organic structures, waiting on our loves,
Will learn in time to love as well as we.
Thy wealth will multiply organic forms,

And all will multiply their own fair kind.
These will be thy offspring, our progeny.

VAPOUR. Our end, and aim, the sequel to our loves.
How pure, how rare, how beautiful!—and then?

LIGHT. I have command to make bright worlds of love;
We have the Beginning, and the present;
Moments of love, and models for their duty
In all the varied sequence of the law.
So we must trust in that Omnipotent,
By whom we were created, are maintained,
From whom we gain the privilege of love,
To give a fitting future to our race;
Measured to us, by what we mete to Him.

VAPOUR. Our present, and our future hang upon
Attention to my duty, and my love.

LIGHT. They do!

BOTH. For ever, and for ever! Be it so!

LIGHT. I bring a wand'ring Vapour to Thy care,
The Earth, my Glory, and Thy world of love!

CREATOR. 'Tis very good! forsake ye not My law!

Have we reached a natural Beginning of the history of this earth? We leave others to answer the question. We have run through many surface phenomena in the "Circle of Light, or Dhawalegeri," "The Interior of the Earth," "New Pages of Natural History," and "Incidents in the Biography of Dust." Each inci-

dent we have narrated, and each phenomenon we have touched on, owe their condition and existence to the system we have here imperfectly described. We have shown that the exact sciences of the present day cannot make their ends meet, not from any defect in their own calculations, but in consequence of their uncertain data, derived from the nebular hypothesis of Laplace. In placing this by the side of the slow aggregation theory of Gruithuisen, we find more natural action in the latter, but no entire nature in either. They leave behind them the whole material in the shape of nebulous dust. Present science allows that condition. In default of any other, we have accepted it under the name of vapour, holding in its body the bases of all the minerals and metals now found, seen, and felt in uncounted composition on and in this earth. In forming the planets under the first incidence of light, we explain the condition of the larger and more distant worlds as noticed by Mr. Proctor. They need not yet be in a state of consolidation, and hence their lighter vapours may be in the confused condition described by him, but that apparent condition may be due to other causes than that of heat. We have not touched on the chemical changes brought about by light and heat; they have been constantly discussed, but till we know what matter and light are, no satisfactory conclusions can be

reached. M. Cailletet and M. Raoul Pictet have, as we have shown, found liquids and solids in the gases of this world. It is fair to deduce from this fact that gases, liquids, and solids composed the nebulous dust, the vapour of the beginning. As far as we know, these times were dark and cold, till the first glimmer of light fell upon the mass, and slowly gave a motion to a new world, slowly and surely attracting to itself the gases, till the atmosphere and the waters were made, and the molecules of matter sunk into their natural state of solidity. Until we know more of the nature of matter and of light, this system seems to offer a true picture of the Beginning.

THE END.

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Digitized with financial assistance from the
Government of Maharashtra
on 18 July, 2018